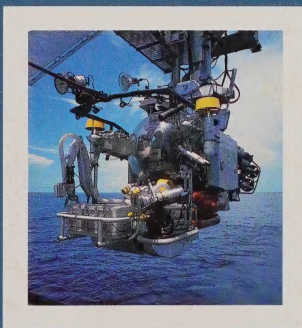
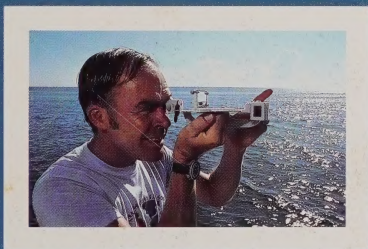
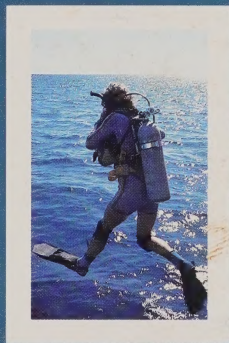
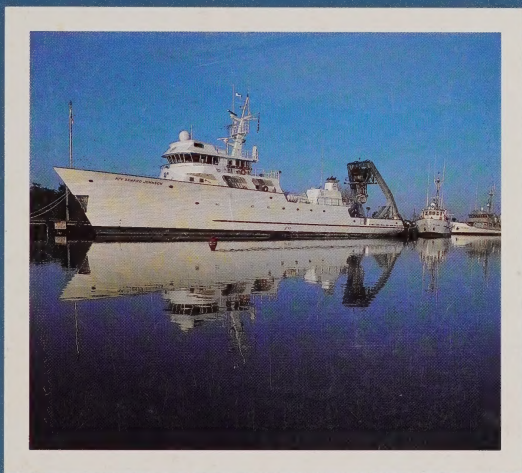
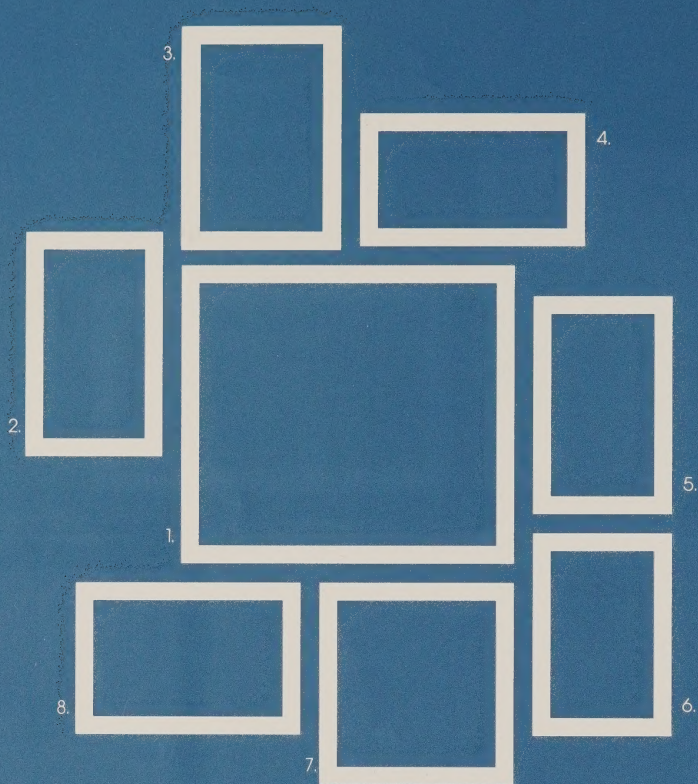


1986 ANNUAL REPORT



HARBOR BRANCH
OCEANOGRAPHIC INSTITUTION, INC.



COVER:

1. R/V SEWARD
JOHNSON,
R/V SEA DIVER,
R/V EDWIN LINK
2. Caribbean King
Crab, *Mithrax*
spinosissimus, with
eggs
3. Beachside Morning
Glory produced
through tissue
culture
4. Deep-sea medusa,
Paraphylla
paraphylla
5. Scuba diver Gwen
Burzycki
6. Knot meter
7. JOHNSON-SEA-LINK
submersible
8. Dr. Ned Smith
measures azimuthal
bearings with
sextant

Photos by Tom
Smoyer with the ex-
ception of #5, by
Susan van Hoek

TRUSTEES

J. Seward Johnson, Jr.
James L. Johnson
Jennifer U. Johnson
Marilyn C. Link
Carl W. Schafer

DIRECTORS

J. Seward Johnson, Jr.
Marilyn C. Link
William W. Wood
Jerome P. Keuper
Carl W. Schafer
Charles H. Bussmann
James S. Hill

OFFICERS

J. Seward Johnson, Jr.,
Chairman, President,
Treasurer

Marilyn C. Link,
Vice President,
Assistant Secretary

Louis R. Hewitt,
Controller,
Assistant Secretary

Fred W. Nichterlein,
Secretary

Richard J. Herman,
Assistant Secretary

President's Message



J. Seward Johnson, Jr.
Chairman of the Board and President

I am happy to transmit this annual report to the Trustees and Board of Directors. I would characterize last year as "a new beginning" for Harbor Branch. As you know, Harbor Branch won a significant addition to its corpus in the litigation over our founder's will, and we emerged from that situation intact and ready to get back to business. We have also taken a new name that better represents our goals and objectives, and we have a new managing director, and a new director of the Division of Marine Sciences is joining the staff. We have purchased and modified a new remotely operated vehicle (ROV) which will allow us to maintain our lead role in undersea vehicles for science. We are completing an important new building for the Harbor Branch/SeaPharm Project, and we have had an unprecedented year in Marine Operations which started with the CHALLENGER space vehicle recovery mission and ended with SeaPharm's mission to the Galapagos Islands.

I view 1986 as a productive beginning to the new emphasis; that of Harbor Branch taking its place in the national effort in marine sciences. Our challenge in the upcoming year will be to continue progressing and obtaining the external funds necessary to support new and exciting programs, and to produce even more publications on the work that is going on at Harbor Branch Oceanographic Institution.

I hope you will find this annual report to be informative in its coverage of the year's activities. It should provide you with a sense of our mission as well as our goals and expectations for the future.

A large, stylized handwritten signature in dark ink, which appears to be "J. Seward Johnson, Jr." The signature is fluid and cursive, with a prominent initial "J" and a long, sweeping underline.

Contents

President's Message	1
Director's Introduction	3
Division of Marine Science	4
Support Facilities	8
Division of Applied Biology	10
Harbor Branch/SeaPharm Project	14
Division of Ocean Engineering	18
Marine Operations	22
Finance Division	24
Properties	25
Personnel Services	26
Public Affairs Office	26
Interactions	27
1986 Cruise Schedules	28
Grants and Contracts Funding	29
Personnel Listing	30
Fellows, Students, & Visitors	32
Publications	33

Director's Introduction



Dr. Jay Langfelder
Vice President and Managing Director

The 1986 Annual Report represents the initiation of a new format for reporting the activities and progress of Harbor Branch Oceanographic Institution, Inc. on a yearly basis. The intent is to highlight those activities in each of the operating and support divisions that have contributed to our progress during the past year.

The activities are reported on a divisional and departmental basis for ease of reading and preparation. However, the progress during the year should be evaluated from an overall standpoint. The strength of the organization derives from all the staff at Harbor Branch working together to reach the dual goals of enhancing our scientific and engineering program in the marine environment and providing state-of-the-art systems for undersea research.

1986 was a productive year for Harbor Branch, as indicated by the following highlights:

- Research grants in the divisions of Marine Science, Applied Biology, and Engineering increased by 31% over 1985, to approximately \$1,041,000.
- The number of publications resulting from our research increased to 31 papers published, with an additional 56 papers accepted for publication in 46 different journals.
- The ship operations experienced the busiest year ever with 419 total operating days, of which 312 were funded by outside agencies. This year also marked the first time a Harbor Branch ship operated in the Pacific Ocean and in the Southern Hemisphere.
- The eight postdoc housing units were completed and occupied, and the in vivo testing facility was essentially completed and will soon be occupied.
- Dr. Richard Harbison, a Senior Research Scientist from Woods Hole Oceanographic Institution, accepted our offer to become the Director of the Marine Sciences Division.

We look forward to 1987 with eager anticipation. We expect to add to our scientific staff, increase our funded research, begin construction of the new wing to the Johnson Science Laboratory, and operate R/V SEA DIVER with the newly acquired ROV aboard.

I trust that readers will find this annual report both interesting and informative. ~~~~

A handwritten signature in cursive script that reads "Jay Langfelder". The signature is written in dark ink on a light background.

Division of Marine Sciences

Introduction

Last year the Division of Marine Sciences continued to conduct research in a broad spectrum of disciplines, which included basic investigations of fundamental questions and studies addressing specific and immediate environmental problems. The staff of nearly 40 people, including 14 doctoral level scientists and postdoctoral fellows, is associated with seven major research programs. In a geographic sense, their research emphasized the biology of plants and animals inhabiting estuarine, continental shelf, and open ocean environments, ranging from Bahamian waters to the Gulf of Maine. The majority of research involved investigations of the life histories of organisms and their role in the marine and estuarine food webs, which included details of their reproduction, development, morphology, growth requirements, position in the food chain, and the effects of physical factors on their biology. Studies were conducted in resident laboratories, in the field, and on board Harbor Branch research vessels, using a variety of oceanographic equipment and the manned JOHNSON-SEA-LINK (J-S-L) submersibles.

A significant portion of the research carried out during the past year was supported by 16 local, state, and federal sources, including the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA). Funding totaled \$297,758 in 1986 and involved collaboration with scientists from at least 30 federal agencies, universities, and research institutions; and 10 foreign countries. Fifty-six papers were published or are now in press, in scientific journals and special volumes. (See pages 29 and 33.) The research staff also presented over 90 papers at regional, national, and international meetings.

The following section briefly describes the major areas of research conducted within the division.

Reproductive Biology Program

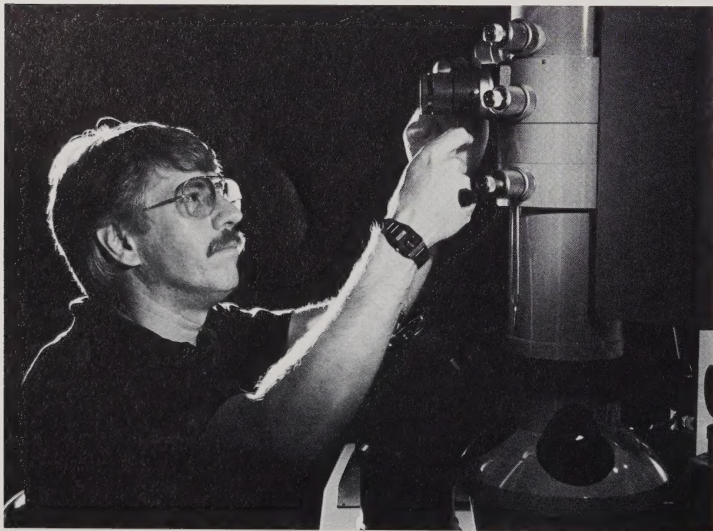
Dr. Kevin Eckelbarger and his staff have been engaged in three major research projects. In a collaborative study with colleagues at the Marine Biological Laboratory, Woods Hole, and with funding from NSF, unique methods are being sought to identify members of sibling species complexes in capitellid polychaetes, common pollution-indicator organisms that are extremely difficult to identify in benthic surveys. This study has demonstrated differences in chromosome numbers, enzyme alleles, reproductive mode, breeding seasons, egg size, egg yolk components, larval morphology, copulatory spines, and ultrastructural details of the sperm and eggs, all of which offer practical means of species identification.

A second research project is intended to shed light on how mechanisms of yolk synthesis in marine organisms regulate or influence their reproductive cycles. A study was initiated with colleagues from North Carolina State University on yolk formation in the eggs of the common estuarine polychaete, *Streblospio benedicti*, a poecilognonous species exhibiting both planktotrophic and lecithotrophic modes of larval development. Preliminary results have shown that two kinds of yolk bodies are synthesized in the egg during development, formed in different proportions in the planktotrophic and lecithotrophic eggs. Early analyses suggest that enhanced diet can trigger the acceleration of specific pathways of yolk synthesis in the planktotrophic eggs, resulting in increased fecundity.

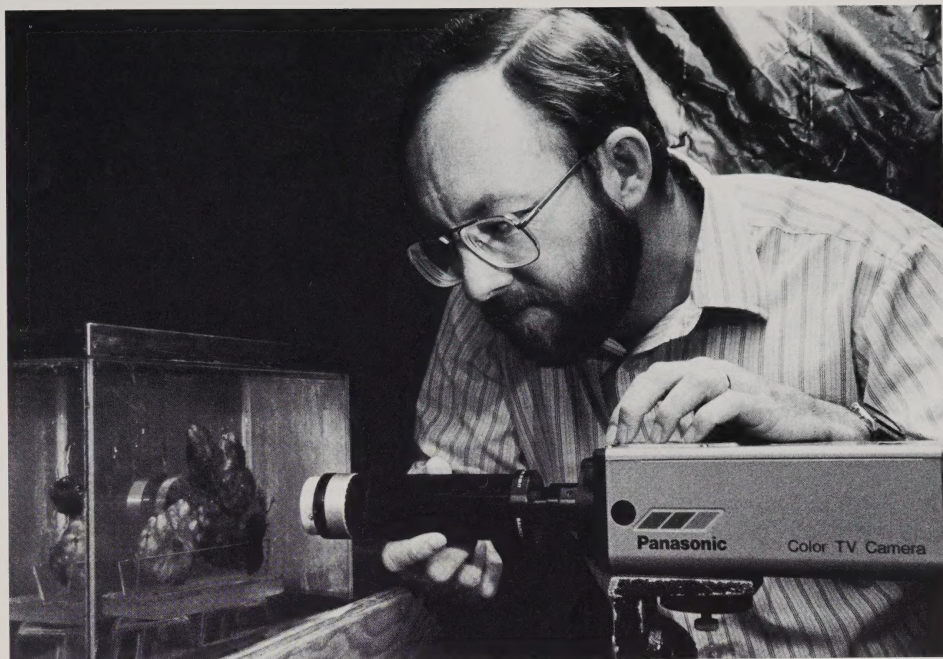
An additional research project was initiated with scientists at the University of Southern California to study the uptake of dissolved organic materials, such as amino acids, through the epithelium of soft-bodied benthic invertebrates. Specifically, autoradiographic and ultrastructural methods are

being employed to determine if absorbed organic materials can be transported to the ovary for use in yolk synthesis during oogenesis. Although amino acids are known to be transported through the body wall epithelium of many marine organisms, it has not been determined if these materials are selectively absorbed by the ovary for use in egg production.

The Transmission Electron Microscope is a major tool for Dr. Kevin Eckelbarger's research on the reproductive biology of invertebrates.



Dr. Craig Young prepares to monitor ascidian activity patterns as part of an NSF-sponsored study of benthic larval ecology.



Larval Ecology Program

During the past year, scientists in the Larval Ecology program completed several major field and laboratory experiments, documenting the effects of benthic filter-feeders on larvae settling in seagrass meadows. Under the direction of Dr. Craig Young, the researchers have described chemical defense mechanisms in ascidian tadpoles and alcyonacean planulae, and have shown that the defenses correlate with larval color.

A large-scale study of settlement in barnacles and serpulid polychaetes was also carried out, in which settlement pattern and intensity was correlated with wind speed and direction, current direction, and location of adult source populations. A study was initiated to monitor changes in populations of sessile invertebrates, especially ascidians and sponges attached to mangrove roots in the Florida Keys and the Indian River estuary. Experimental studies are attempting to explain processes underlying spatial distributions and abundance patterns in these animals.

The ova from several bathyl echinoderms were successfully fertilized and followed through early development, after being collected by the J-S-L submersible in Bahamian waters. Since these observations are among the first ever made for bathyl species, this work will continue in the next year and will focus on descriptions of developmental mode, larval nutrition, and larval orientation mechanisms in some of these animals.

Echinoderm Biology Program

The Echinoderm Biology group, led by Mr. John Miller, conducted several projects this year involving the systematics, ecology, and behavior of littoral and bathyl species from Floridian and Bahamian waters. In cooperation with colleagues at the Smithsonian Institution, a study is underway that will result in a monographic revision of the shallow-water (<100 meters) holothurians of the western Atlantic. The monograph will contain abundant illustrations, including scanning electron micrographs of skeletal ossicles of over 80 species of shallow-water holothurians, to provide the scientific community with a practical guide to their identification.

Collaborative investigations are also being conducted with Smithsonian scientists to produce an atlas describing the diverse echinoderm fauna inhabiting the steep, submerged slopes between 100-825 meters off the Bahama Islands. Collections and *in-situ* photography, using the J-S-L submersibles, have yielded more than 140 species, including 12 that are new to science, along with new observations on distribution, feeding and swimming behavior, commensal relationships, and color patterns. Lastly, under a cooperative agreement with the Sanctuary Programs Division of NOAA, a project was initiated to survey the echinoderm fauna of the Looe Key National Marine Sanctuary near Big Pine Key, Florida. More than 70 species, collected from depths between 1-40 meters, will be included in a field guide of the resident species occurring throughout five distinct habitats in the Sanctuary, for use by specialists, non-specialists, and park officials responsible for managing natural resources.

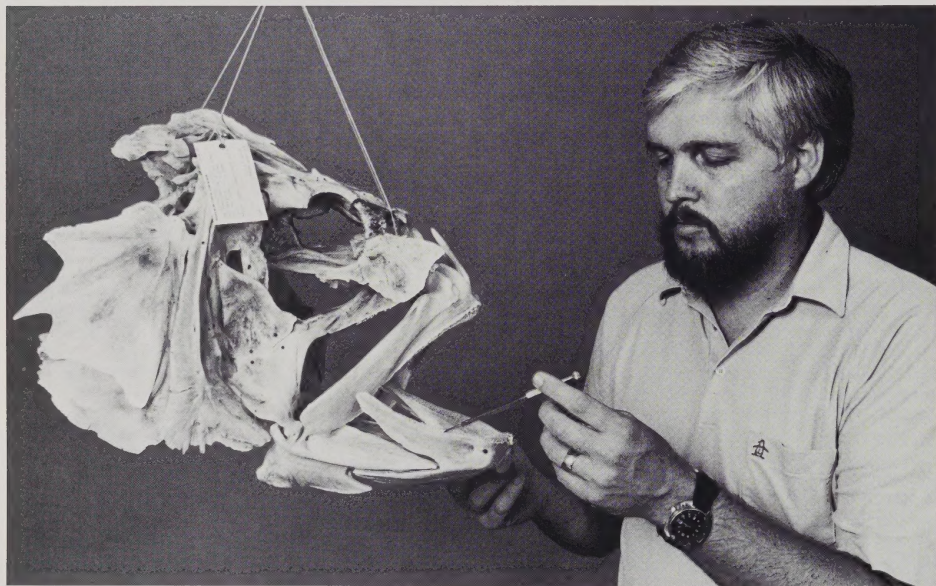
Zooplankton Ecology Program

Members of the program headed by Dr. Marsh Youngbluth have been conducting studies from Bahamian waters to the Gulf of Maine, using the J-S-L submersibles. One study has focused on the source, abundance, stratification, and flux of large particles, principally marine snow aggregates and zooplankton fecal pellets, which represent primary vectors for the rapid, downward transport of organic production from the mixed layer. Studies have indicated that particle densities can be high in narrow depth intervals (5-20) meters. In the Gulf of Maine, such stratifications may form near physical boundaries coincident with the base of the thermocline. Dense aggregations of the giant larvacean, *Bathochordeus charon*, concentrate each spring in the Gulf Stream in a 45-65 meter layer, which overlaps with the subsurface chlorophyll maximum at 50-70 meters. The ovoid filter houses that this organism builds and abandons, average 30 centimeters in diameter and constitute a substantial source of mucoid debris, which extends downward to 200 meters, along the continental shelf of Florida. Data collected

thus far indicate that larvaceans and the microbial assemblages that attach to their filter houses represent an important mechanism for modifying, repackaging, and transporting significant amounts of particulate material from the ocean's interior.

Other studies are examining the energy requirements of midwater gelatinous zooplankton such as mesopelagic ctenophores. A recent investigation of the common ctenophore, *Bathocyroe fosteri*, indicated that its basic metabolic demand (ca. 9% body C d⁻¹) was similar to that of epipelagic species but its daily maintenance ration could be 10-100X smaller than shallow-water ctenophores.

Another area of investigation is the distribution, density, and behavior of demersal zooplankton in seagrass and coral reef habitats, utilizing remotely operated traps to correlate daily vertical movements with changes in solar, lunar, and tidal conditions. Data collected to date reveal emergence patterns that differed among taxonomic groups, among species within a group, and among developmental stages within a population.



Ichthyologist Grant Gilmore with skull of a large serranoid grouper, *Epinephelus itajara*.

Fish Biology Program

The Fish Biology program, directed by Mr. Grant Gilmore, expanded its research personnel during the past year in order to deal with three major research programs. State, federal, and private funds are sponsoring research on subtropical salt marsh fish population dynamics. This study is quantitatively examining fish, avian, and macrocrustacean population dynamics relative to various environmental conditions, such as diel period, hydrology, meteorology, and water chemistry in a recently recognized ecosystem, the subtropical halophytic succulent high marsh.

With the aid of the J-S-L submersibles, the team is describing the previously unexplored tropical

reef ichthyofauna of the Bahama Islands between 100 and 400 meters. Collections, behavioral observations, and documentation of population size and microhabitat associations have been made with video and still photography.

Finally, research continued on the embryology and reproductive biology of lamnoid sharks, a group for which little is known. The first detailed description of development in one species, *Odonaspis tauris*, has been published. Additional information has also been gathered on mating grounds, sperm activity in the oviduct, features of gonadogenesis, sequence in collagen secretion and ovulation, ovulation rates, frequency of twinning and triplets, and embryonic mortality during various phases of intrauterine development.

Marine Botany Program

The Marine Botany team, led by Dr. Dennis Hanisak, continued a long-term study seeking to characterize deep-water algal communities in subtropical and tropical areas, using the J-5-L submersibles. The study includes habitat descriptions and the identification of physiological responses, and adaptations of these algae to their preferred environment. An algal recolonization study has been funded by NOAA's Marine Sanctuary Program as a result of the grounding of the freighter, WELLWOOD, on Molasses Reef, which is one of the most popular coral reefs for sport divers in the country. The study will provide a taxonomic description of the algal community of Molasses Reef for comparison with similar communities in the unimpacted peripheral areas.

Another project was organized to focus on systematic, morphological, and natural history



studies of predominant species of *Sargassum*, an important algal species in Florida waters. Current research is concentrating on population monitoring for seasonal patterns of growth rate, productivity, reproduction, and senescence. Relationships and affinities between different taxa are being investigated, along with the influence of environmental factors on growth and morphology.

Another research project is characterizing the macroalgal community in the Indian River estuary in terms of species composition, abundance, seasonality, growth rates, productivity, and

nutrient dynamics. Research suggests that diverse assemblages of floating macroalgae, which are common in the estuary, are ecologically significant and have profound effects on other components of this ecosystem.

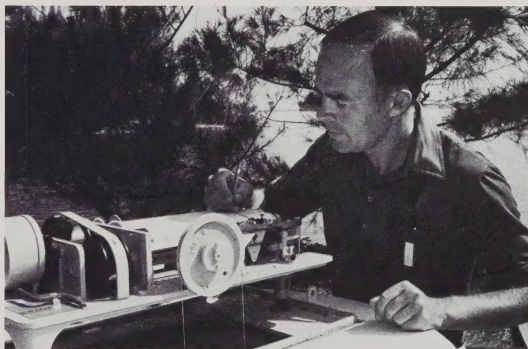
The Marine Botany department, led by Dr. Dennis Hanisak, currently has several programs that study the systematics, ecology, and physiology of macroalgae.

Physical Oceanography Program

Throughout the year, scientists under the leadership of Dr. Ned Smith were involved in the characterization of cause-and-effect relationships between time series of oceanographic and meteorological variables in estuarine and shelf waters. Local studies include an investigation of flushing in the Indian River lagoon and the analysis of current meter data from the shelf break between latitudes 27 and 30 N. The flushing of the lagoon is being quantified, using water level and current data collected from the southern segment in 1981. A numerical model has been developed to quantify the residual tidal flow (baseline flushing level).

Another continuing local study involves the use of current and temperature data from the shelf break to study upwelling onto the shelf in winter months. This data base is from a segment of coastline connecting two regions where two forms of upwelling have been recorded. Results will show how the transition occurs.

Two additional studies were conducted in Texas coastal waters. A numerical model is being developed to simulate longshore and cross-shelf flow in response to windstress. Results should be useful for estimating the cross shelf transport of fish eggs in the surface layer and suspended sediments in the near-bottom layers. A second study is an ongoing investigation of the heat budget of Corpus Christi Bay, in which both air-water and water-sediment heat exchanges are being calculated; advective fluxes will be estimated as a residual. The data base covers a one-year period, allowing the opportunity to consider time scales from hours to seasons.



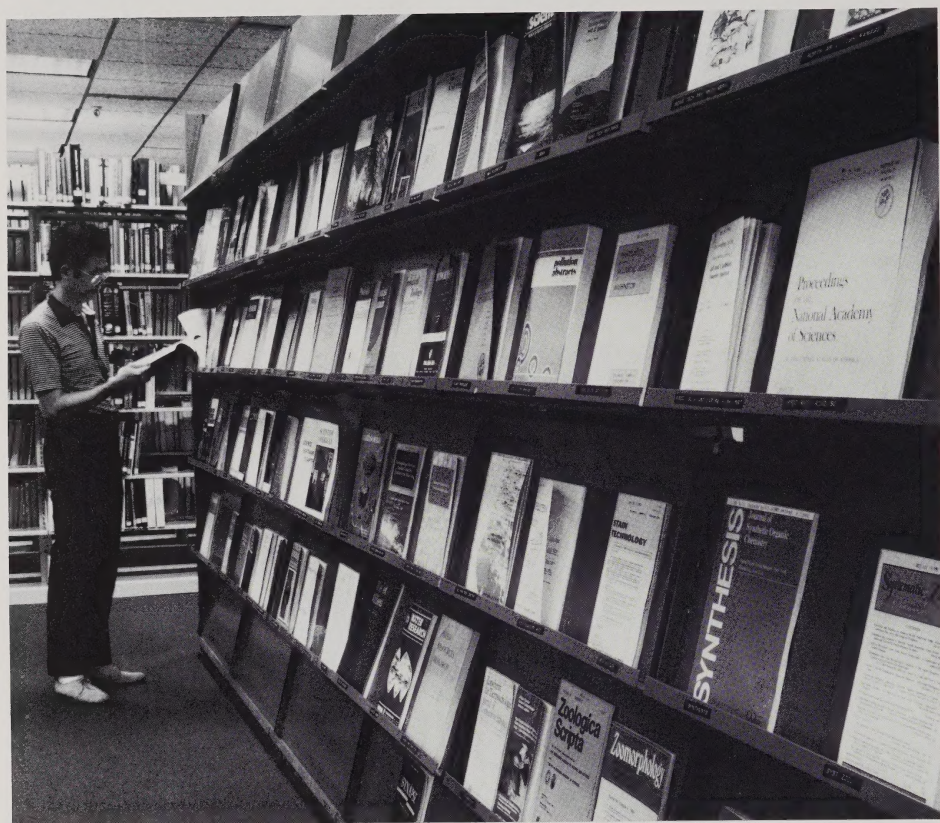
Physical oceanographer Dr. Ned Smith with a water level recorder used in studies of Indian River lagoon tides.

Projection:

Changes in the Marine Sciences division during 1987 include plans to recruit three additional scientists to the staff, to enhance existing programs. Currently, the staff must seek outside contacts for several areas of marine science, particularly marine chemistry. A fellowship program is being developed that will allow students from other institutions to work in the division while conducting their graduate research, which will increase manpower and provide intellectual stimulation for the resident staff. Adequate laboratory and office space is becoming a critical problem, particularly in light of plans for the addition of new personnel. Immediate remodeling of some existing laboratory and office space is planned, along with the anticipated construction of additional facilities to accommodate new staff. Expansion of facilities will also permit visiting investigators to conduct research at Harbor Branch, an option that has been limited in the past by space restrictions. ~~~~

Marine Science Division

Support Facilities



Staff scientists routinely consult the library's current periodical collection.

Four facilities within the Division of Marine Sciences continued to provide the specialized information, expertise, and technical equipment essential to conducting marine science research. These include the Marine Research Library, the Indian River Coastal Zone Museum, the Electron Microscope Center, and Photographic Services.

Marine Research Library

The past year, 1986, marked the eleventh anniversary of the Marine Research Library. Until 1975, when Harbor Branch hired a librarian to develop the collection in a room measuring 160 square feet, the "library" consisted of 100 books and 25 periodical subscriptions, stored anywhere space could be found.

By 1978 the library had grown, with publications stacked from floor to ceiling, to the extent that it had to be moved into a larger area. A new facility was built and the collection moved to occupy 3,500 square feet on the second floor of the Link

Engineering Laboratory. At present, the library subscribes to 265 journals. In 1986, additional shelving and seating areas were added to accommodate the growing collection of 11,000 books and bound journals. In addition to the bound volumes, a new video tape library was also established.

The library staff, which now includes the librarian, an assistant librarian, and a volunteer, has continued throughout the year to provide specialized services to Harbor Branch personnel. Interlibrary loan and reference services were also offered. Through online computerized literature searching, great amounts of information were accessed in brief periods of time. The staff also distributed on request the many publications by Harbor Branch employees that are stored in the library.

In addition to Harbor Branch personnel, a growing number of outside organizations such as the Florida Institute of Technology, the Florida Medical Entomology Laboratory, and the Florida Department of Environmental Regulation make use of the Marine Research Library.

The Indian River Coastal Zone Museum

Throughout the year, a staff of two continued to collect, catalogue, and add to a collection of nearly 23,000 cataloged lots of zoological specimens housed in the museum. These lots are the culmination of 13 years of research by Harbor Branch and Smithsonian Marine Station scientists on shallow and deep water organisms from the Indian River lagoon and adjacent Florida and Caribbean waters. More than 3,700 species are represented in the collection, primarily composed of marine invertebrates and fish. The museum, which incorporates a progressive computerized

cataloging system, has continued to serve the scientific community through an extensive, world-wide specimen loan program.

Highlights in 1986 included the receipt of significant collections of medusae, siphonophores, corals, gastropods, and holothurians from the Bahamas, Florida, and the Caribbean. In addition, eight scientific papers reporting on specimens housed at the museum were published by researchers during the year. Research by museum staff was concentrated on the biology and systematics of echinoderms and molluscs.



Preserved sharks are among the more intriguing examples of specimens in the reference collection.

Electron Microscopy Center

The Electron Microscopy Center (EMC) and the Histology Laboratory, located in the Johnson Science Laboratory, were established in 1976 and 1978 respectively. In the ensuing ten years, use of the facilities by more than 130 scientists, including resident staff, postdoctoral fellows, summer interns, visiting investigators, and Smithsonian Institution associates, has resulted in 124 publications on such various subjects as reproductive biology, devel-

opmental processes, taxonomy and systematics, morphology, and geological processes.

The EMC contains a Zeiss 952 transmission electron microscope which magnifies from 140 to 60,000 times, and a Zeiss Nova-Scan scanning electron microscope that magnifies from 25 to 150,000 times. Ancillary equipment includes a Hummer sputtering unit for coating specimens prior to scanning, a Denton vacuum evaporator, glass knife makers, and a darkroom with an Arkay film processor and Beseler and Durst enlargers, while an adjacent ultramicrotomy room holds Porter-Blum ultramicrotomes for ultrathin sectioning of tissue for transmission work.

The Histology Laboratory is a centralized facility, fully equipped for fixation, dehydration, infiltration, embedding, sectioning, and staining of specimens for light and electron microscopy. Specialized equipment includes hoods, microscopes, rotary microtomes, Autotechnicon tissue processor, ovens, paraffin dispenser, microtome knife sharpener, and a critical point drying apparatus.



A scientist specializing in systematics utilizes the scanning electron microscope to photograph skeletal ossicles from sea cucumbers.

Photographic Services

The photographic services department was made available to, and highly utilized by, Harbor Branch personnel and their associates throughout the year. To meet photographic and communications needs, the department provided black and white and color film processing, copy and reproduction photography, black and white and color still photography, photographic instruction, audio/visual programming, and VHS video services.

Division of Applied Biology

Introduction

Throughout the year, the Division of Applied Biology (DAB) continued to carry out research on aquatic organisms of direct benefit to human needs and immediate commercial applicability. Research included both freshwater and marine organisms and systems, and was directed toward both products and technology of commercial value. As in the past, a major thrust was the cultivation of aquatic organisms not grown before in captivity. Such research includes the breeding throughout the entire life cycle of aquatic plants, molluscs, crustacea, and fin fishes; and involves such disciplines as developmental biology, nutrition, genetics, behavior, pathology, and aquatic engineering.

Target species for aquacultural development were selected on the basis of their existing or potential value for such diverse purposes as human food, fertilizers, soil conditioners, commercially valuable chemicals, and biologically active compounds; for seed stocks of juvenile organisms; for wastewater treatment; for toxicological studies of the environmental effects of pollutants; and for biomedical research. Evaluation of such uses of the cultured organisms is also a continuing and essential part of DAB's research program.

This division consists of five research programs, staffed by 22 people, including six doctoral level scientists and four postdoctoral fellows. Sixteen papers were published or are now in press. Much of the research was supported by local, state, and federal agencies, including the National Science

Foundation (NSF) and the Agency for International Development (AID), and totaled \$601,938. (See pages 33 and 29).

The major projects of DAB are described in the following section.

Unicellular Algae

The Solar Energy Research Institute supported the research of Dr. Roland Carlson, to isolate, characterize, and evaluate the growth of new species of algae high in lipid content and otherwise potentially valuable as sources of hydrocarbon fuels. One hundred and forty species of algae were isolated from microhabitats in the Florida Keys and the Everglades, where they were found in "bloom" conditions. Of those, 57 isolates were chromophytes; special targets of the project because they had previously been found most likely to have high lipid content. Thirty-five species showed high growth rates under full sunlight conditions. At least three of these had unusually high concentrations of lipids, and experiments successfully induced lipid productions to still higher levels in two species, through manipulation of culture conditions.

The high lipid strains were added to the permanent culture collection as likely candidates for mariculture food organisms and as possible sources of 3-omega fatty acids (microalgae being the ultimate source of those compounds that give certain fish species their beneficial qualities to human health).



Cultivation in floating rafts and net pens in the Indian River lagoon of a variety of the red seaweed *Gracilaria* that contains an unusually high quality of agar.

Macroalgae

The red seaweed, *Gracilaria tikvahiae*, has been grown in culture, and its growth, nutrition, physiology, and biochemistry studied intensively, for several years, under contract with the Department of Energy and the Gas Research Institute. This study is part of a large program to evaluate the potential of marine biomass as an energy source. A more recent interest in *Gracilaria* is in its potential as a source of the commercially-valuable polysaccharide gum, agar.

Variety G-16 of the DAB culture collection of *Gracilaria* species was identified as producing an agar of commercial quality, both by Harbor Branch personnel and by U.S. and Japanese agar manufacturers. This is the only warm water seaweed known that has both high agar quality characteristics and good growth rates. Research has shown that agar quality does appear to be

affected by seasonal changes and culture conditions, with nitrogen depletion causing an increase in agar content but a decrease in gel strength. Stocking density of the clone in tanks does not appear to affect quality, but does influence growth rates. Alternative methods to tank cultivation are being pursued, including a small seaweed "pen" and a net farm structure. This work was supported in part by a grant from the National Science Foundation to Dr. Kimon Bird.

In the biomass program, a macroalgal cultivation system was built at the new Florida Institute of Technology (FIT) Vero Beach Laboratory. The system was designed to receive ocean seawater, and new macroalgal species are being grown there that could not be cultivated in the brackish water available at Harbor Branch. These include *Gracilaria debilis*, *Sargassum* spp., *Gelidium*, and *Pterocladia erocladia*.

Clam Culture

The DAB mollusc group was initially established to develop and improve shellfish culture technology. To that end, a pilot-scale hatchery was established. Current intense interest in hard clam (*Mercenaria mercenaria*) farming in the Indian River, and a chronic shortage of seed clams, essential for the establishment of such an industry, has focused attention on the Harbor Branch experimental hatchery. Accordingly, both DAB physical facilities and staff were expanded, culminating in the appointment in June, 1986, of Dr. David Vaughan as hatchery manager and head of the mollusc department.

With concomitant advances in the technology for mass culture of unicellular algae, the small experimental facility evolved into a full scale commercial clam hatchery; the only such source of seed clams in the Southeastern United States. With projected production of 10 million seed in 1986, and expected expansion beyond that goal in future years, sales could easily support the hatchery operation and a significant accompanying research program in shellfish genetics, feeding, and nutrition, and the development of culture technology for new species as well.

Several million seed hard clams (*Mercenaria*) were produced in the shellfish hatchery for planting in the Indian River lagoon, as part of the region's new clam farming industry.



Cultivation of Queen Conch

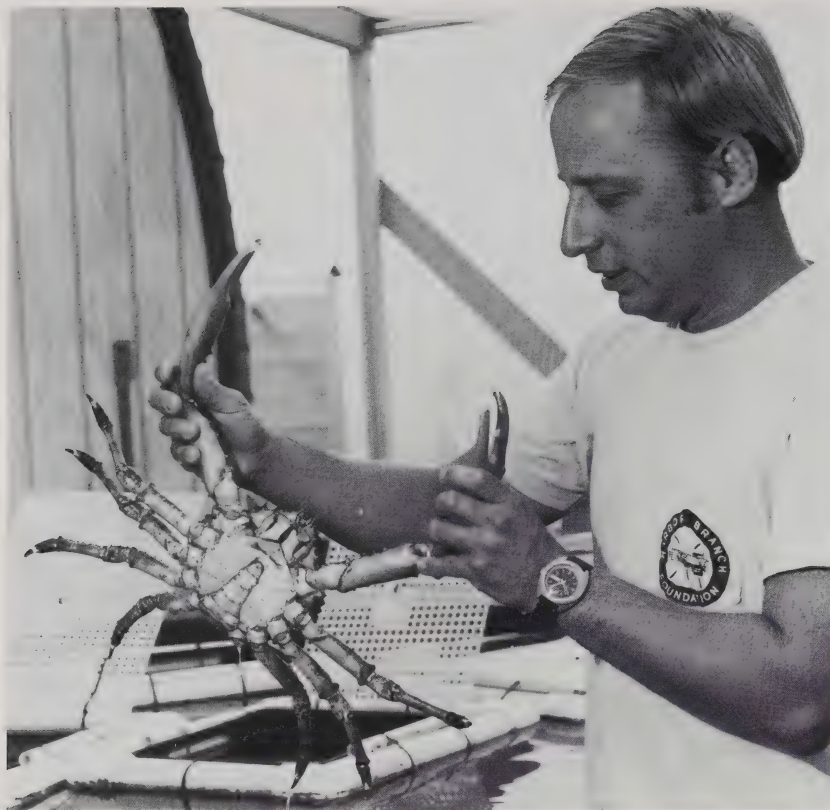
The queen conch, *Stromus gigas*, an important fishery resource in Haiti, has experienced drastic declines in natural populations due to exploitation. Through funding by the United States Agency for International Development (AID), a program to evaluate the feasibility of releasing juvenile hatchery reared conchs into near-shore habitats denuded of conch stocks was begun. Mr. R. LeRoy Creswell of DAB provides technical advice for the implementation of a growout program for conch juveniles imported from a hatchery in the Turks and Caicos Islands. Queen conch juveniles are housed in floating cages and fed algal turfs until they grow to five centimeters. They are then tagged and released in waters adjacent to the nursery site, and their growth and survival monitored.

Mr. Creswell also began providing technical support to another AID Program in Science and Technology Cooperation with the government of Belize, Central America. This study, titled "A Genetic and Demographic Assessment of Queen Conch, *Stromus gigas*, Populations, and the Development of an Onshore Research Facility," was originated to determine the genetic relationships between geographically distinct populations of queen conchs in Belizean waters. By using starch-gel electrophoresis techniques, the degree of genetic similarity among conch populations

and their contribution to recruitment of the conch fishery can be ascertained.

Based on design specifications provided by Harbor Branch personnel, a research facility equipped with a seawater system, a temperature controlled phytoplankton area, and modern scientific instrumentation was constructed in Belize. Queen conch egg masses collected from several populations in Belize were cultured at the facility, and their progeny were found to be genetically different from natural populations. The laboratory has also been put to use as a classroom for marine science education by the local schools and as an important research facility of the Belize Fisheries Administration.

A third contract was granted to DAB, to provide technical assistance to the Caicos Conch Farm, a commercial hatchery for the mariculture of the queen conch. Mr. Creswell was instrumental in the design of the larviculture and phytoplankton production systems as well as the hatchery protocol for the successful culture of this species. Production from this hatchery has exceeded one million juvenile conchs per month. Research and development of appropriate methods for off-shore culture of small juveniles, and the extensive farming of conchs to harvestable size, is now underway. Currently, Mr. Creswell is assisting hatchery scientists in addressing special problem areas such as techniques for induction of metamorphosis, post-larval nutrition, and conch pearl induction.



Mariculture technology is under development for the large Caribbean spider crab, *Mithrax spinosissimus*, a relative of the Alaskan King Crab.

Caribbean King Crab Mariculture

A new grant was awarded by AID to develop a culture technology for the Caribbean king crab, *Mithrax spinosissimus* (a large spider crab similar in size and appearance to the Alaskan king crab), under the direction of DAB Director, Dr. John H. Ryther. Other attempts to create an artesinal cage culture system, to be operated by local fishermen, had met with limited success, largely because very little was known about the basic biology of the crab including such fundamental information as nutritional requirements at all stages of the life cycle, feeding behavior and preferences, growth rates, reproduction biology, and larval development. These aspects of *Mithrax* biology will be studied at the Harbor Branch mariculture facility by Dr. Robert Winfree. An experimental *Mithrax* hatchery was constructed at the FIT Vero Beach Laboratory, where access to open ocean water should ensure survival of the delicate, early stages of the crab. A hatchery technology for producing large numbers of juvenile *Mithrax* on demand will be developed by LeRoy Creswell, who will be assisted by Dr. Bjorn Tunberg, an FIT postdoctoral fellow supported by the Harbor Branch Education Program.

Meanwhile, field studies will be carried out on the island of Antigua, where DAB is constructing an experimental maricultural facility, by new Harbor Branch staff, Antiguan assistants, and Peace Corps volunteers. The field station is being de-

signed and constructed by John Holt, DAB Aquacultural Engineer. Field studies in Antigua, complementing those to be carried out at the Harbor Branch and FIT facilities, will culminate in a pilot project for the rearing of 1,000 crabs to marketable size (3-4 lbs).

Game and Food Fish Culture

Several of Florida's estuarine fishes have good potential for aquaculture. Research on three of these continued this past year under the direction of Dr. John Tucker. A three year study of culture requirements for common snook, *Centropomus undecimalis*, was completed. Sheepshead, *Archosargus probatocephalus*, were again spawned during April but were not reared. Adult spotted seatrout, *Cynoscion nebulosus*, stocked in raceways, spawned voluntarily throughout the summer of 1986. Larvae were used in toxicity tests and in growth experiments.

Cooperative research on barramundi, *Lates calcarifer*, with the Queensland, Australia state government began in November 1985 with a three month visit to that country by Dr. Tucker. Barramundi, also in the snook family, has problems similar to those of Florida's snook with habitat loss, pollution, and fishing pressure. A series of experiments were conducted with juvenile barramundi to determine feeding schedule, growth, feed conversion, and response to different combinations of temperature and salinity.

Tropical Fish Culture

Research into the propagation of valuable exotic tropical fish concluded after achieving dual objectives to determine the commercial potential for new, rare and valuable species, and to develop the technology to rear wild-caught juveniles to functional reproductive adults. Reproductive control was achieved for the first time in four species, each from a different taxonomic family (the green spotted scat, *Scatophagus argus*; the silver mono, *Monodactylus argenteus*; the archer fish, *Toxotes jaculator*; and the firetrack eel, *Mastacembelus armatus*). The breeding of *Scatophagus argus* and the photodocumentation of its early larval development marked the first reported observation of either event in the family Scatophagidae. The valuable cyprinid, *Barbodes schwanenfeldi* (tinfoil barb), was also bred, demonstrating that such high-value species, never before propagated in captivity, can be reared in Florida.

Marine Toxicology

A two year study of the toxicity of three organophosphorous insecticides to estuarine animals was conducted by Drs. John Tucker and Katherine Thompson for the state of Florida. These insecticides, sometimes sprayed by aircraft or truck to control adult mosquitoes, could accidentally drift into estuarine or coastal waters and affect on-target organisms. Through field and laboratory tests, this study determined toxic effects on larval and juvenile fish, larval clams, and adult copepods. Because some insecticides and spraying methods were found to be more dangerous than others, recommendations for safer practices were made to mosquito control authorities.

The first phase of a study on the toxicity of oil ash on semi-tropical reef dwelling organisms was completed early in 1986 as part of a larger study funded by the Florida Power and Light Company. The study, in conjunction with scientists at FIT, was undertaken to determine the suitability of blocks made from fossil fuel wastes for construction of artificial reefs. Laboratory tests have shown that water around oil ash blocks has little if any toxic effect on numerous marine species, ranging from bacteria to seaweed and finfish in culture. Preliminary field tests indicated that blocks are also non-toxic to algal and invertebrate communities that grow attached to block surfaces. There was evidence, however, that some animals accumulate metals associated with the oil ash.

Further research by Dr. Katherine Thompson, funded by NOAA through Florida Sea Grant, will focus on potential long-term accumulation of metals from oil ash blocks by organisms inhabiting the reefs. Both laboratory and field experiments will focus on identifying pathways and mechanisms of uptake, accumulation, and potential for transfer through the food web of toxic metals present in oil ash.

Under the terms of a new contract with the office of Naval Research, Dr. Roy Laughlin has begun studies of the effects of tributyltin compounds on survival, growth, and development of all life history stages of oysters and clams, and of bioaccumulation of the toxicant by the animals. Tributyltins are

the active agents of modern antifouling coatings. The goal of research is to provide information to prevent adverse impacts on sensitive, non-target organisms that might be harmed by inappropriate use of coatings containing tributyltin.

Projection:

Consistent with its stated objectives, the division will continue to develop new mariculture technology involving both new species and new culture methods. The AID-funded project on the cultivation of the Caribbean king crab, *Mithrax*, will admirably fulfill those objectives. Research on one or more species of reef fishes, such as snapper or grouper, that would be suitable for cage culture on the small Caribbean island nations is also critically needed and is a longer term objective.

Nearer to home, the angel wing clam, with which some preliminary research has already been done, remains an intriguing Southern U.S. equivalent of the Northern soft-shelled, or "steamer" clam, and would appear to have substantial market potential. Asian mollusc species, such as the green mussels, *Perna*, and the giant clam, *Tridachna*, also appear appropriate for tropical mariculture in the Western Hemisphere, and need testing and evaluation.

While a variety of *Gracilaria* with agar of superior gel strength is now successfully in culture, alternative culture methods that are economically viable must be designed and evaluated before even pilot testing of a commercial grow-out operation is attempted. Finally, the large bank of unicellular algae that have already been isolated and are now maintained in our culture collection should be thoroughly tested and evaluated as mariculture feeds, human food, and for chemical feedstocks.

Funding is the major constraint to this research. Core support from the Institution is now sufficient for little more than the overhead for running the DAB facility and the support of its administrative and maintenance staff. The small remainder, which was formerly spread among several in-house projects, is inadequate and non-cost-effective, one project at a time. Others must depend upon outside funding, which becomes increasingly scarce whether from federal, state or private sources.

As support for aquaculture continues to diminish, emphasis must shift by necessity to toxicological and environmental studies that are still somewhat more readily funded. Attempts will also be made to combine the two programs and objectives by soliciting support from the National Institutes of Health and/or other appropriate agencies, for cultivation, strain selection, pure line breeding, and maintenance of culture collections of organisms used for bioassay studies and other forms of environmental monitoring.

A secondary constraint to mariculture research at Harbor Branch is the poor quality of the available seawater from the Indian River. This becomes a serious deterrent, particularly in attempts to culture or work with living oceanic or coral reef species. Some respite may be obtained through limited access to the small seawater system of the FIT Vero Beach Laboratory, but a permanent sub-station on the ocean would appear to be the only satisfactory, long-term solution to the problem. ~~~

Harbor Branch/SeaPharm Project

Introduction

The Harbor Branch/SeaPharm Project, a unique association of the Harbor Branch Oceanographic Institution with the international pharmaceutical company, SeaPharm, Inc., has continued with its objective to develop new drugs from marine organisms for treatment of human disease. The preclinical drug discovery and drug development activities of the project, conducted on the Harbor Branch campus at Fort Pierce, includes the identification of drugs for cancer, viral infections, and fungal disease as well as for disorders of the immune system. The uniqueness of this venture lies in the source of starting material: marine microorganisms and macroorganisms collected with the use of scuba gear and the Harbor Branch research vessels, and with JOHNSON-SEA-LINK submersibles. These collections were evaluated by Harbor Branch/SeaPharm scientists in a system of proprietary biological assays. The most promising samples were then purified and subjected to more stringent testing, as they progressed toward human clinical trials.

The four drug-oriented programs (antitumor, antiviral, antimicrobial, and immunomodulator) were supported throughout the year by other organized research activities such as taxonomy, chemical synthesis, cultivation of blue-green algae, and fermentation of marine microorganisms. Scientists were able to evaluate the biological activity of organism extracts on board ship, and additional in vitro testing was conducted in shore based laboratories.

Organisms with promising activity were subjected to the established procedure: They are provided to chemists who isolate, purify, and identify the active compounds; advanced in vivo testing further selects those chemicals that may be of clinical interest; synthetic chemists are then asked to supply the large amounts of drugs necessary for clinical trials; and patents are requested for compounds of interest. Other sources of marine material: algal cultivation, microbial fermentation (bacteria, yeast, fungi, actinomycetes), and submissions from outside investigators are also subject to stringent testing.

The major accomplishments of this project reflect its primary goal to discover, develop, and market effective new pharmaceuticals. Of the 4,000 organisms collected in 1986, over 800 extracts were evaluated intensively, from which about 70 pure, structurally identified compounds were produced. The structures of a large number of other pure, bioactive compounds are currently being determined. Twenty patents were filed on the most promising drugs representing significant progress in each of the disease-orientated groups. To date, nearly 30 agents have shown in vivo activity in various disease models.

The staff of 37 people in the Harbor Branch/SeaPharm Project includes 15 doctoral level scientists and three postdoctoral fellows, who are associated with 11 research programs. Grants and contracts in 1986 totaled \$253,166, with an additional 1.4 million dollars under contract for 1987-91, awarded by the National Cancer Institute (NCI) and a large private organization. (See page 29.)



Harbor Branch/
SeaPharm Project
scientist using underwater
photography to document
a potential sample
for future collection.

Harbor Branch/
Sea Pharm Project
Nuclear Magnetic
Resonance Spectro-
meter used to determine
molecular structure
of new marine
natural products.



Antitumor Research

The antitumor group in the Harbor Branch/SeaPharm Project is the most fully developed of the research programs. Only about 20 clinically useful drugs are now available for human treatment, making this an important and relevant area of study. The known antitumor agents are highly toxic and have a limited range of activity. While 50% of some types of cancers can be cured by drugs, radiation, or surgery, others, such as colon, lung, and metastatic breast cancer, are highly resistant to all current therapy. In the Harbor Branch/SeaPharm antitumor program, human and mouse tumor cell lines, plus a targeted assay for DNA interaction, are used for primary characterization of the antitumor activity of organism extracts. Secondary testing includes chemical characterization, additional mechanism of action assays, a proprietary dereplication assay, and in vivo testing. In vivo testing is carried out to determine chemical toxicity and the antitumor effectiveness of drugs against solid tumors and leukemias. Over 30 pure anticancer compounds have been identified in the last year, resulting in 11 patent applications. This group is composed of three biologists and four chemists. A new Research Animal Facility, approximately 4,500 square feet, was constructed to conduct in vivo testing of the Harbor Branch/SeaPharm Project.

During the past year a number of potential lead agents with in vivo anticancer efficacy were identified under the direction of Drs. May Lui and Oliver McConnell. These leads, with a diversity of structural chemical types, are in various stages of



development, including advanced testing, chemical synthesis, and licensing. Several contracts have been funded by the National Cancer Institute (NCI). One contract involves the search for novel antineoplastic agents from macroorganisms indigenous to mangrove swamps and diverse intertidal areas on the Florida coast. Taxonomists, tumor biologists, and natural products chemists are involved in this study.

Dr. May Lui performs
quantitative in vitro
evaluation of the anti-
tumor potential of an
extract of a shallow
water tunicate.

Antimicrobial Research

An NCI contract was granted for the study of marine-derived microorganisms as sources of anticancer agents. This is a cooperative study between scientists in the anticancer and antimicrobial study groups. The latter group is working in three areas; the use of marine microorganisms as producers of novel pharmaceuticals; the search for new antibiotics; and the search for new antifungal agents. Terrestrial microorganisms such as bacteria, yeast, fungi, and actinomycetes have traditionally yielded about half of the pharmaceuticals currently in use. Until now, there has been no major systematic study of marine organisms as sources of new drugs.

In this project, microbes will be isolated from deep water submersible collections in the Caribbean and Galapagos Islands, from shallow-water scuba collections off reef areas in the same locations, and from near shore environments along the Florida coast. Specialized isolation procedures and conventional fermentation techniques will be used to provide materials for evaluation in a spectrum of biological assays used by the Harbor Branch/SeaPharm Project. The NCI contract will be part of this ongoing study, but will concentrate on looking for microorganisms producing anticancer drugs.

The microbiology group also continues to look for antimicrobial agents. The concentration is in the search for antifungal agents that can be used against life-threatening fungal infections found in the elderly and in patients with severe immunological impairment, such as AIDS victims, organ transplant patients, and those being treated by chemotherapy for cancer or other diseases. The list of current effective agents in this category is extremely limited, and those drugs have limited effectiveness and/or toxic sequelae. The Harbor Branch/SeaPharm Project tests collected marine organisms against filamentous fungi and yeast, including *Aspergillus nidulans* and *Candida albicans* (cause of major systemic fungal-related morbidity and mortality, and vaginal candidiasis) as well as a panel of dermatophytic fungi. Also included are target directed enzymatic and biochemical screens. A number of interesting leads have been developed using these assays and several were identified for further development. The four scientists associated with this research effort interact extensively with other programs by supplying fermentation preparations for evaluation for antitumor, antiviral, and immunoregulatory activities.



Testing a new anti-cancer drug extracted from a marine sponge. Mice bearing a fatal leukemia can be cured with some marine natural products from Harbor Branch/SeaPharm Project research.

Antiviral Research

The antiviral drug group at Harbor Branch/SeaPharm has developed a panel of a number of useful RNA and DNA viral models and used them to evaluate over 4,600 organism extracts. Of these, a large number have demonstrated antiviral activity. Pure compounds from sponges collected in Australia, Okinawa, and the Bahamas show exciting activity and a number are being carefully evaluated in, in vivo test systems. Three biologists and three chemists are devoting their efforts to this program under the direction of Drs. Sue Cross and Frank Koehn.

Immunology

The immunomodulator project was established in 1986 and is already yielding immunostimulatory and immunosuppressive leads, which can selectively modulate the human immune response, for application in the areas of transplant surgery, autoimmune disease, arthritis, and adjuvant therapies for infectious diseases and cancer. Modifying the aberrant behavior of the immune system requires drugs of exquisite selectivity. This in turn requires the design of preclinical test systems aimed at mechanisms of action for specific subsets of the immune system, such as T-cells, B-cells, macrophages, and natural killer cells. Using some of these systems, Dr. Glynn Faircloth has shown that some extracts of cyanobacteria, or of macroorganisms from Spanish coastal waters, can enhance the activity of immune cells by a factor of a thousand or more. Other organisms have been found to be potent for suppressing the immune response.

*The Harbor Branch/
SeaPharm Research
Animal Facility is
scheduled for comple-
tion early in 1987.
Research will be dedi-
cated to the study of
marine-derived drugs in
a variety of animal
models.*



Algal Culture

The algal culture project is different from the above mentioned projects because it is directed toward the isolation, culture, and discovery of cyanobacteria containing novel pharmaceutical agents. Field samples were collected on major expeditions and isolated to unialgal, or axenic culture. Algal strains were grown in illuminated culture vessels and extracts were tested for pharmacologic activity. Approximately 200 separate isolates have been evaluated. Based on test results in the antitumor, antiviral, and immunomodulator areas, a number of extracts from these organisms are being studied by Harbor Branch/SeaPharm chemists.

Promising activities in these areas have resulted in the initiation of product optimization studies. These studies are designed to define the culture conditions (light, temperature, pH), medium composition, and ratio between media components that stimulate the maximum genetically possible biosynthesis of the bioactive compound by blue-green strains. Optimization experiments thus provide information about physical and nutritional factors that control secondary metabolism in blue-green algae, as well as information for the successful scale-up of biomass production necessary for advanced development and clinical trials. The construction of large, 250 liter, biomass growth chambers is nearing completion. These chambers will be used for the scale-up production of algal strains already identified as promising.

Chemical Synthesis

Another method of meeting the need for large-scale production of pharmaceuticals of interest is the chemical synthesis program. Synthetically approachable chemicals are being produced, based on activities noted from biological testing. A by-product of these efforts has been the identification of chemical intermediates with novel chemical structure and pharmacological activity.

A second objective of this program is to synthesize analogs and congeners of lead compounds that have superior efficacy or reduced toxicity from the parent compound. Structure-activity relationships derived from these studies help optimize the efforts of the Harbor Branch/SeaPharm Project to develop pharmaceuticals from marine resources.

Collaborations

The drug discovery effort is aided considerably by collaboration with investigators involved in marine research. Productive arrangements have been established with research groups in Australia, New Zealand, Okinawa, and Israel. Each of these scientific groups have worked for a number of years to identify unique chemicals from marine organisms. They are currently collecting and identifying organisms from their local waters, and isolating bioactive compounds as part of the Harbor Branch/SeaPharm program. SeaPharm, Inc. was awarded a five-year contract from the National Cancer Institute to collect organisms in the waters around Australia and New Zealand.

Projection:

Goals for 1987 reflect the need to continue progress toward the development of pharmaceutical agents that are effective against human disease. Each project expects to produce a number of preclinical candidates with solid *in vivo* activity. Several drugs will probably pass through toxicology and be in clinical trial. Patents and licensing agreements will follow the scientific productivity of the project. Scientific progress will mature by the implementation of sophisticated new assay systems and the addition of scientific personnel. The expected growth of scientific programs, plus the award of government contracts, will require additional laboratory space to meet the ambitious goals and objectives of the Harbor Branch/SeaPharm Project.

Division of Ocean Engineering



A Summer Intern from the Mechanical Engineering Department prepares acrylic sphere models for pressure test.

Introduction

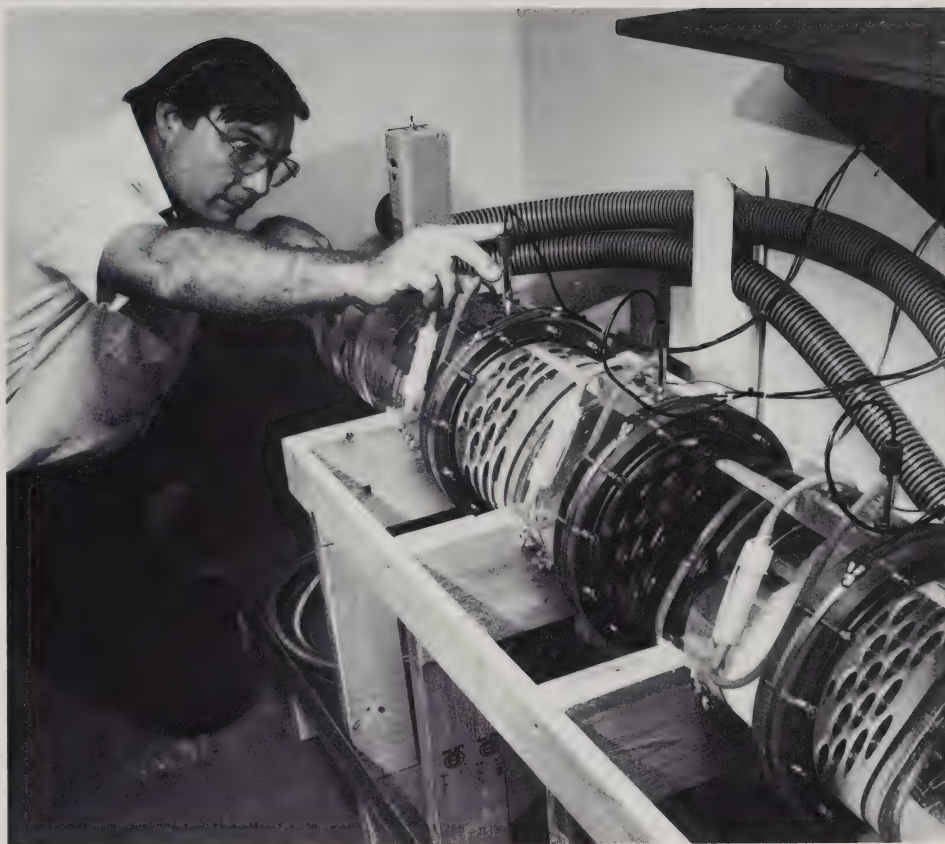
Throughout 1986, the Division of Ocean Engineering continued in two major directions; to provide engineering support and technical services to other divisions within Harbor Branch, and to conduct engineering research and development programs in the areas of mechanical, electrical, and chemical engineering. In the past, the development or enhancement of submersible tools, instrumentation, and laboratory hardware to fulfill research needs provided much of the utility that is the hallmark of such Harbor Branch systems as the JOHNSON-SEA-LINK submersibles. Last year the division continued to provide the often required assistance of engineering personnel for repair, preventive maintenance, and improvements to Harbor Branch vessels and property, while the production facilities enabled them to quickly manufacture needed parts or systems. The division

also provided Harbor Branch with operational and programming support for the central computer system, as well as with numerous micro-computer systems utilized throughout 1986.

In the area of engineering research and development, the departments of Mechanical, Electrical, and Chemical Engineering continued to conduct programs designed to further current engineering knowledge and to develop systems in anticipation of the future needs of the marine scientist.

This division is comprised of a staff of approximately 32 persons, including four doctorate level engineers and postdoctoral fellows. During 1986, the division undertook nine additional projects, supported by local, state, and federal sources. Funding totaled \$140,818 for these projects. In addition, 15 papers were published or were in press in journals and special volumes. (See page 33.)

Chris Tietze of Mechanical Engineering inspects an apparatus for determining the tenacity of protective coatings used in heat exchangers.



Mechanical Engineering

During the past year, the Mechanical Engineering Department, headed by Mr. Andrew Clark, completed the development of several sampling systems for use by in-house and outside investigators aboard the J-S-L submersibles or other comparable systems. Continuing improvements to the Lower Work Platform of the submersibles were made, providing researchers with more productive methods for collecting grab or suction samples along with entrained water. To enhance the Lower Work Platform, a new filtering system was added, which will allow scientists to collect samples from the near-bottom 'fluff' layer.

Continuing evolution of submersible technology was the focus of a major mechanical engineering design project. The preliminary design and testing of an acrylic sphere capable of operation to a depth of 8,000 feet was initiated and is now being tested in the department's new automated pressure test facility. Currently undergoing long-term cyclic testing, 6-inch-diameter and 15-inch-diameter models are being subjected to conditions equivalent to 1,000 submersible dives, to 8,000 feet. In addition, the facility is able to test pressure vessels up to 24-inch-diameter at pressures to 5,000 psi.

Electrical Engineering

Throughout the year, the Electrical Engineering Department, headed by Dr. Frank Caimi, continued to design, develop, construct, and implement systems and sub-systems that involve the broad scope of electrical or electronic technology. In the recent past, a concentration on systems either directly photographic in nature or that aid in the use of photographic systems improved significantly the quality and quantity of still and video pictures taken by submersibles. The development of submersible-based laser systems for range-finding and size estimation increased the ability of the pilot or observer to accurately aim underwater cameras. With the new laser range-finder, a submersible pilot can place an object to be photographed at the precise center of both picture frame and depth-of-field. Two parallel beams, spaced a known distance apart, provide a pair of reference marks for estimating the size of any object of interest. These reference marks are also recorded on video tape and made available for review after the dive.

A second project initiated by the Electrical Engineering Department, with major input from other division personnel, was the development and construction of an Instrumentation Array for use by the David Taylor Naval Ship Research and Development Center. The system was devised to monitor a hydrophone cable array and to position a directional hydrophone. The project was the first contract work undertaken by the Division of Ocean Engineering for the Department of Defense.

In the area of internally generated research, the Electrical Engineering Department concentrated in two basic fields; the development of instrumentation for measuring optical characteristics of water and its fundamental properties, and the use of fractal geometry in the areas of object recognition and classification. The instrumentation studies led to the development of a Transmissometer/Scatterometer for making measurements of suspended particle loads in seawater, which was the first system to utilize a solid-state laser diode emitter providing increased illumination at lower power consumption. As a by-product of the instrument development, additional information on the operational characteristics of laser diodes was developed.

Departmental research in fractal geometry, which is a new mathematical regime, employed statistical analysis to recognize and classify objects from certain characteristics of their shapes. Some areas that could benefit from this work are silhouette recognition and species classification by shape. Additionally, fractal statistical analyses were employed in the description of light propagation in the submarine environment.

Chemical Engineering

The Department of Chemical Engineering continued to conduct research in two major disciplines; a study of the effects of water contamination and development of monitoring and clean-up methods as related to groundwater and surface water systems; and closed cycle life support and environmental control systems, concentrating on the mechanisms of CO_2 absorption and the design of scrubber systems.

In the areas of groundwater pollution, the Chemical Engineering Department's manager, Dr. Tsen Wang, was again recognized as a leader in the local geographic area. Several municipalities contracted ongoing grants with Harbor Branch to evaluate, monitor, and recommend solutions to local problems with contaminated groundwater. In addition, a cooperative effort with the Division of Applied Biology investigated the

toxicity effects of aerial spraying of mosquito impoundments on local fish populations. The Chemical Engineering Department provided the information on decomposition times of chemicals used in the spray study.

Two postdoctoral fellows, Dr. Chee Kai Tan and Dr. Mike Liou, have been working with Dr. Wang on two projects of special interest. Dr. Tan is investigating methods of decomposing volatile organic compounds by the use of catalyst and sunlight. Dr. Liou is working to develop a better understanding of the process of CO_2 absorption by Lithium Hydroxide (LiOH), and to develop a numerical model of the absorption process that will allow the evaluation of scrubber design prior to actual construction.

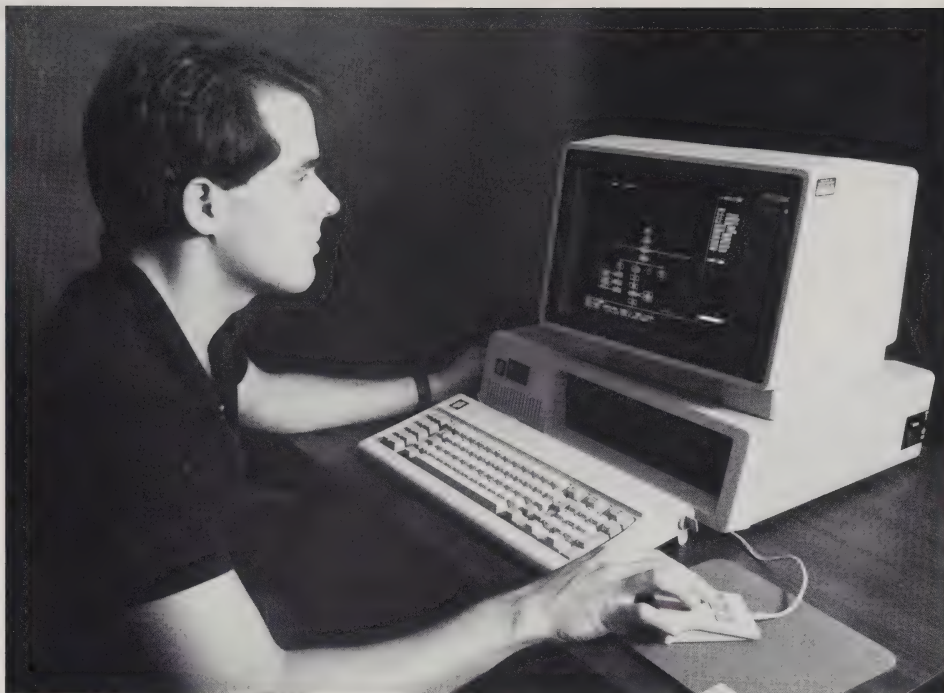
Drafting Support Services and Production Shop

During 1986, the service departments, drafting and the production shop, headed by Mr. Bob Dolan, continued to provide the design and construction functions that support the three engineering departments and often the rest of Harbor Branch. The year 1986 also marked the retirement of Chief Design Draftsman Bob Quinn, who was employed in the drafting department since its inception in 1972.



One of the miniature LASERs developed by the Electrical Engineering Department to improve underwater photography.

A programmer/analyst develops program flow-charts as part of software documentation.



Computer Services

The Harbor Branch computer service department, headed by Mr. Thom Cerwonka, provides the major information highway and computing resources for almost every effort at Harbor Branch. During the past year, Computer Services developed several large database systems to allow rapid entry, organization, and reporting of research data. One major project example was the Organism Tracking System, designed for the Harbor Branch/SeaPharm Project to provide rapid data entry, manipulation, and reporting of all organisms collected, stored, and tested. The system provides researchers with the ability to locate all tests performed on a single organism or on all organisms that meet certain defined criteria.

During the fourth quarter of 1986, an upgrade to the computer system was installed by Computer Services. The new computer, a PRIME 9955 Mod II, provides a several-fold increase in processor power while also running the existing suite of programs and packages.

Projection:

The three engineering departments are actively pursuing outside funded projects to supplement in-house funding. In particular, results of preliminary studies by the Electrical Engineering Department in fractal geometry projects are the center of discussions for funding by several federal research sponsoring agencies. The division is also making a

concerted effort to identify and target areas of internal expertise for the design and development of instrumentation needed by local and national organizations.

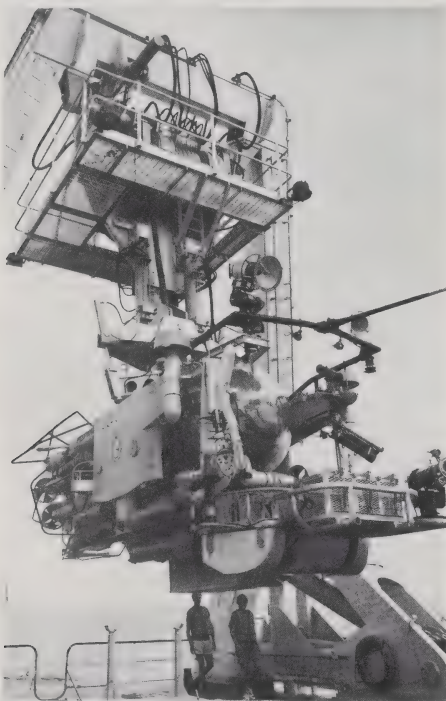
Much engineering effort is required to support internal science and operations needs. In previous years, sufficient manpower and materials were available to devote to these job requests. However, recent changes in ship scheduling, and the amount of time spent at sea, has meant a turn from the process of continuing development (with time available for integration of systems on the submersible) to responding to intense, immediate requests that require short development duration. These urgent demands can outstrip the ability of the Ocean Engineering Division to comply. There is also a need for engineering to conduct independent research, requiring the allocation of sufficient time, manpower, and materials to provide a reasonable assurance of success. The interaction of internal support and independent research, two sometimes conflicting functions, stresses the division's resources and capabilities.

Alternating periods of intense work on the research vessels and submersibles, with little need for support work when the vessels are at sea, make scheduling long-range projects and establishing priorities extremely difficult or impossible to accomplish. There is a critical need for the development of a system that will allow scheduling for required work and research projects, which will also provide sufficient time for planning and accomplishing all of the work in the most productive way. ~~~~~

Division of Marine Operations

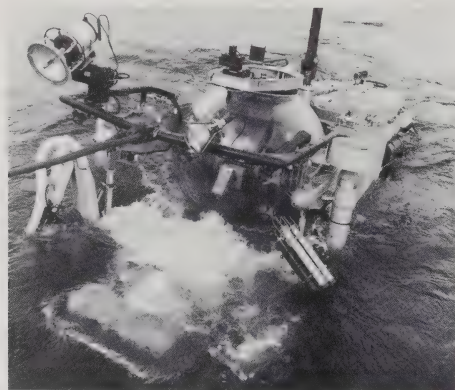


First in line at the Harbor Branch Link Port Channel is the recently commissioned research vessel SEWARD JOHNSON, followed by R/V SEA DIVER and R/V EDWIN LINK.



Throughout the year, the Division of Marine Operations supported missions for the in-house Division of Marine Sciences and the Harbor Branch/SeaPharm Project; and for the National Oceanic & Atmospheric Administration (NOAA) and their Undersea Research Program, and NOAA's University of Connecticut Undersea Research Program. Funding from these and other agencies, including Eastport International for work with NASA, amounted to 3.6 million dollars.

The staff of 46 people includes submersible pilots, mechanics and technicians, ROV specialists, marine maintenance personnel, administrative personnel, and specialized ship's crews. Several



The free-swimming, four-man submersible, JOHNSON-SEA-LINK II, is launched and begins another dive for science from the stern of R/V SEWARD JOHNSON.

Introduction

The primary objective of the Division of Marine Operations for 1986 was to continue to operate and maintain the Harbor Branch fleet of research vessels and undersea vehicles that support marine science research. The fleet consisted of the research vessels (submersible support ships), SEWARD JOHNSON, 176' x 36'; EDWIN LINK, 123' x 26.8'; and SEA DIVER, 100' x 22.6'; the manned diver lockout submersibles, JOHNSON-SEA-LINK I and II, which are rated to a depth of 2,640 feet; and three remotely operated vehicles (ROVs), CORD II, 3,000 feet; HYSUB 40, 3,280 feet; and MiniROVER Mark I, 400 feet.

staff members authored and coauthored published papers, including Mr. John Reed, Mission Coordinator and Dive Safety Officer, and Mr. Tim Askew, Manager of Undersea Vehicles. Mr. Roger Cook, Marine Operations Director, served on five national committees including the ALVIN review committee, and chaired the Marine Technology Society's Undersea Vehicles Committee, which earned the Professional Committee of the Year award.

Ship scheduling last year was made difficult because of the unexpected extended mission for NASA (see Highlights), and it was a busy season for all of the Harbor Branch vessels. The 1986 Cruise Schedule is listed on page 28.

Highlights

The past year was a memorable one for Marine Operations because of an unusual national mission: For the first time, the division supported something other than marine science research. Following the tragic failure of NASA's CHALLENGER on January 28th, R/V SEWARD JOHNSON with JOHNSON-SEA-LINK II and R/V EDWIN LINK with JOHNSON-SEA-LINK I helped to identify and recover key portions of the downed space shuttle. Captain Daniel Schwartz, Master of R/V SEWARD JOHNSON, and Captain Art Plante, Master of R/V EDWIN LINK, along with ship and submersible crew members, spent several months of steady work on this project.



ROV operator Louis Blaisdell checks the pan and tilt mechanism controlling the video camera and strobe on the new HYSUB 40.

The Marine Maintenance Department undertook the refurbishing of the marine railway. The 1986 annual maintenance period for R/V SEA DIVER, captained by Mr. Edmond Warren, was devoted to modification and construction of a new wet lab/dry lab and the beginning of the conversion to an ROV support ship.

Another highlight in the Division of Marine Operations was the purchase of two new, state-of-the-art, remotely operated vehicles, HYSUB 40 and MiniROVER. Both underwater vehicles are being used as additional support for marine science research.

Projection:

The goals and objectives for 1987 are to continue to support marine science research with R/V SEWARD JOHNSON, R/V EDWIN LINK, and JOHNSON-SEA-LINK I and II, and to complete modifications of R/V SEA DIVER, making the vessel an ROV support ship, especially for the new HYSUB 40.

R/V EDWIN LINK, formerly R/V JOHNSON, was the first Harbor Branch submersible support ship. She is old (59 years) in the life of sea-going vessels, which is usually projected to be 20 to 30 years, and is no longer state-of-the-art. R/V EDWIN LINK should be retired and replaced with a new state-of-the-art submersible support ship to better fulfill the growing demand for ship/submersible time for marine science research. ~~~~

In the Florida office, the Finance Division, directed by Mr. Rick Herman, continued to be responsible for financial reporting and budgetary control of operations throughout the year. (The Harbor Branch, Princeton, New Jersey office is responsible for investment activity and tax reporting). Departments within the division include general accounting and record keeping, accounts payable, payroll, purchasing, cost accounting, and grants and contracts administration.

During the past year, the Harbor Branch employee Pension Plan was completely restated and submitted to the Internal Revenue Service for approval. The restatement was necessary to insure that the plan complies with recent tax and pension legislation, and to provide for certain other changes, such as the addition of "rollover" provisions to make the funds more portable to the participant.

A new MARCOM telephone system was

installed, utilizing state-of-the-art equipment and providing for specific identification of costs by department and individual extension. The annual cost of the new system is \$8,000 less than its predecessor.

Also added in 1986 is a new Database accounting and financial management information system. The new system provides for "inquiry" access of data for specialized reports and management information, and provides for the computerization of the purchasing function, resulting in the recording of encumbrances against budget line items for greater budgetary control. The final phases scheduled for implementation in 1987 will permit secured access, by department managers and other authorized persons, to pertinent data regarding department budgets, grant and contract status reports, details of amounts disbursed, and the status of items on order.

Grants and Contracts

The Grants and Contracts Office was established in 1985 to process a large volume of paperwork associated with the ever increasing number of federal, state, and private grants and contracts. During an eighteen month period, from 7/1/85 to 12/31/86, 135 research proposals were submitted to outside funding agencies. The 1986 grant and contract receipts of \$9,821,184 represent a 24% increase over 1985, and include the organization's first direct receipts from the National Science Foundation (NSF) for three marine research grants awarded in 1985. Anticipating increased funding from NSF, the grants office is applying for an Organizational Prior Approval System (OPAS) that, if approved by NSF, would give Harbor Branch internal budget flexibility between line items in accordance with established NSF guidelines. (For details, see page 29.)

Projection:

Looking ahead to 1987, the Finance Division anticipates the completion of its financial database system, the possible addition of a Voluntary Tax Deferred Annuity as a supplement to our existing Pension Plan, and increased grants and contracts activity. ~~~~

Properties

Located beside the Indian River lagoon near the Fort Pierce Inlet, the Harbor Branch property consists of 17 buildings on 443 acres of landscaped and native hammock areas.



The properties management organization, headed by Mr. Rick Gallagher, carried out its responsibility for the overall operation, maintenance, construction, renovation, and security of the physical plant and campus throughout the year. The Harbor Branch property now consists of 17 buildings that total 152,600 square feet, and 443 acres of landscaped and native hammock areas.

The work was carried out through the efforts of 19 persons, including management and supervisory staff. The organization is broken down into the following eight departments: Properties Administration, Housing Administration, Grounds Maintenance, Security, Custodial Services, General Maintenance, Vehicle and Equipment Maintenance, and Construction Services. In addition to the physical plant operations and maintenance, these departments continued to support the operating divisions of Harbor Branch.

In the past year, Properties completed Phase I of a housing project for postdoctoral fellows, consisting of eight units. A cafeteria, located in the Link Engineering Laboratory, was completed and now serves breakfast and lunch Monday through Friday. There was a major remodeling of the executive offices and the accounting office, and a new storage building, providing approved storage for flammable, toxic, and waste chemicals, was completed.

Much of the Harbor Branch physical plant is over ten years old. Last year, the Johnson Science and Link Engineering Laboratories were reroofed. Portions of the domestic water system were also upgraded, and major repairs were made on the heavy equipment used to support the operating divisions.

Other ongoing projects are repair and replacement of channel bulkheads, maintenance dredging of the Link Port channel, and the construction of a 4,900 square foot animal research facility.

Projection:

In the future, the Properties organization expects to replace equipment that is no longer cost effective. An equipment garage should be constructed to reduce maintenance and extend the life of the vehicle and heavy equipment fleet. Harbor Branch will need to replace the air conditioning in the Johnson Science Building, reseal main roads, pave all parking areas as required, and renovate the storage facilities. Possible new projects consist of additional student housing, an addition to the Johnson Science Laboratory, and a new Marine Education Center. Because of these plans, a master site plan and a comprehensive zoning ordinance for the Harbor Branch properties is being developed. ~~~~

Personnel Services

Approximately two hundred employees and consultants of Harbor Branch are eligible for the support services and benefits administered by the Personnel Services Department. Last year, in addition to record keeping and recruitment, the department continued to address the responsibility for the development, implementation, and coordination of policies and procedures regarding placement, training, wage and salary administration, employee relations, workplace safety, and other employee benefits and activities.

The services provided by Personnel include the administration of the Harbor Branch comprehensive insurance package; supervision of the Educational Assistance program; coordination of the Safety Committee's activities; implementation of the wage and salary policies and merit increase program; and coordination of special activities and programs.

One of the special projects directed by Personnel Services is the Annual Summer Intern Program, which supported 10 interns in 1986. At present, this program gives undergraduate students 10 weeks of "hands-on" experience in marine science, engineering, or related fields. At the end of the 10 week period, the intern is responsible for summarizing the results of his/her project in both a written and oral report. The internship program is currently being reevaluated to consider the possibility of expansion to include graduate students.

The Harbor Branch Personnel policies and procedures were given increased visibility in the past year by the introduction of a completely revised Personnel Policy and Procedure Manual. The new manual, changed in style and format for greater ease in both reading and comprehension, outlines the duties and responsibilities of managers as well as providing a convenient source book of the many benefits available to Harbor Branch personnel.

Late in 1986, a new benefit for all employees and their families was implemented. The *Employee Assistance Program* provides a confidential avenue of help for anyone who may be troubled with such issues as substance abuse, marital or family problems, legal and/or financial difficulties.

Projection:

In the coming year, the Personnel department expects to further its goal of increasing employee awareness by developing and implementing a new orientation system; by increasing the activities and hence the impact of the safety committee; by continued emphasis on employee suggestions concerning additions, deletions, and/or changes to our benefit package; and by an ongoing effort to maintain the personnel policy manual in an up-to-date, comprehensive manner. ~~~~

Public Affairs Office

The Harbor Branch Public Affairs Office, with a staff of two, is a multi-level support entity. Last year the department continued to act on a local level as a liaison between Harbor Branch and the people of St. Lucie County and Indian River County, which was accomplished through twice weekly tours, media contacts and news releases, special programs, and the coordination of a speaker's bureau.

On a national and sometimes international level the office continued to act as a public and media coordinator, working closely with TV networks, public broadcasting, and filmmakers; and with magazine, textbook, and other publishers. In 1986, that included coordinating participation in two parts of an upcoming, BBC, three-part series on the Atlantic Ocean; an upcoming, nine-part TV series for PBS; a documentary by NBC on the CHALLENGER search and recovery mission; and coordinating the media for the Summer Mission and extensive coverage of the Galapagos Mission. Early in 1986, Harbor Branch's participation in the space shuttle debris search following the CHALLENGER failure drew constant national and international media attention, which lasted for several months.

Throughout the year, the department was responsible for the preparation, editing, printing, and distribution of in-house and outside publications, general hand-out flyers, a slide show, and the annual report.



Selecting photographs for a variety of in-house and outside publications is but one of the editorial services provided by the Public Affairs Office.

Projection:

Along with the continuation of the above, the Public Affairs Office intends to prepare and place informative feature articles in national publications, based on interviews with Harbor Branch researchers, engineers, and technicians, if time will allow. The staff expects to spend more time with researchers in the field and in the lab, to focus on the many good stories available and thus help increase general science and engineering awareness. Plans are also underway to prepare exhibit materials for in-house use and for outside speakers, and to prepare video releases for the electronic media. ~~~~

Interactions

Harbor Branch Oceanographic Institution continues to interact with a number of other organizations and institutions, and with individuals such as postdoctoral fellows, visiting investigators, summer interns, and graduate students assigned to Harbor Branch researchers.

Articles in the Division of Applied Biology section refer to programs interacting with the Florida Institute of Technology (FIT) whose main campus is located at Melbourne, Florida. In addition to these projects, Harbor Branch conducted a community lecture series throughout the year in collaboration with FIT researchers from their new facility located at nearby Vero Beach, Florida.

The Summer Intern program is discussed in the Personnel Services article, and others are included within the context of divisional reports. The activities of two more immediate programs, located on the Harbor Branch campus at Link Port Channel, are described in the following articles.

Postdoctoral Program

Throughout 1986, the Harbor Branch Institution, an integral part of the Harbor Branch Oceanographic Institution, continued to support postgraduate education through awards of postdoctoral fellowships. The primary purpose of this program is to offer advanced professional training in the fields of marine science, applied biology, ocean engineering, and marine pharmacology at Harbor Branch. The activities consist of postgraduate seminars and directed research projects suited to the common interests of the graduate faculty and postdoctoral students. In 1986, seventeen fellows conducted a variety of investigations in fields such as macroalgal botany, invertebrate reproduction, seaweed cultivation, chemical engineering, and natural products chemistry. This year also marked the opening of an on-campus residential housing complex for postdoctoral recipients.

Smithsonian Marine Station at Link Port

Research at the Smithsonian Marine Station at Link Port has included a resident science program on life history studies of marine invertebrates and a broad spectrum of projects conducted by visiting scientists from bureaus of the Smithsonian Institution in Washington, D.C. The unique environments and the diversity of marine life in the vicinity of Link Port have enabled the Smithsonian's visiting scientists and their colleagues from other institutions to work on a wide variety of topics, such as systematic, ecological, reproductive and behavioral studies on many marine organisms, including algae, meiofauna, molluscs, polychaetes, echinoderms, crustacea and fish. In addition, physical scientists have examined the effects of suspended sediments, chlorophyll, and humic and tannic acids on the spectral quality of underwater light as well as the hydrographic equivalence of volcanic ejecta. Studies on algae and echinoderms have been in collaboration with Harbor Branch scientists.



In the resident science program, research has concentrated on life histories of marine worms of the phylum Sipuncula. Oceanic larvae, collected from the offshore Florida Current and reared to adults in the laboratory, were compared genetically and morphologically with populations of field-collected adults from the nearby shelf. A genetic analysis of a population of parthenogenetic sipunculans, common in the oyster beds of the Indian River lagoon, was also initiated. Under investigation are the questions of larval dispersal as a means of genetic exchange and processes affecting settlement and metamorphosis of marine invertebrate larvae.

In studies of the crustacea of the Indian River lagoon, Dr. Raymond Manning, National Museum of Natural History, and his colleague, Dr. Daryl Felder, University of Southwestern Louisiana, found four new species of shrimp and extended the range for many other species, demonstrating an extraordinarily diverse assemblage of these animals in the Indian River. Another study, by Dr. J.L. Barnard, used cinematography to investigate the tube-building behavior of amphipods.

Dr. David Pawson, echinoderm specialist at the National Museum of Natural History, collaborated with Mr. John Miller of Harbor Branch in a study of swimming behavior of deep-water sea cucumbers. Using the JOHNSON-SEA-LINK submersibles, they documented their observations of this unusual behavior with video tapes and demonstrated that these animals are capable of transporting large quantities of seafloor sediments for great distances.

One of the highlights of the past year was a two-day symposium at Link Port in June, in which Smithsonian scientists presented papers or posters on their current research efforts at the marine station. Of the 18 presentations, four were in collaboration with scientists from Harbor Branch. As part of the program, demonstrations of various research projects, and one of the station's specialized facilities, were held on the Smithsonian's floating laboratory-barge. Also demonstrated were the handling gear and winch operation of the station's 39-foot research boat, R/V SUNBURST. ~~~~

Marine worms of the phylum Sipuncula are common occupants of the oyster beds near inlets in the Indian River lagoon. Having eggs that develop parthenogenetically, they are of particular interest in studies of reproductive and population biology.

1986 Cruise Schedules

Cruise Period	Areas of Operations	Objectives	Institution / Scientist
R/V SEWARD JOHNSON / JOHNSON-SEA-LINK II:			
14 Feb.-19 April	Cape Canaveral	Space Shuttle CHALLENGER	NASA
10-26 June	Bahamas	Training	Harbor Branch Oceanographic Institution
17-23 July	Lake Huron	Lake trout	William Cooper Univ. of Michigan
26 July-1 Aug.	Lake Superior	Opossum shrimp	Larry Boyer Univ. of Wisconsin
4-10 Aug.	Lake Superior	Geomagnetic studies	Dave Long Michigan State Univ.
21-27 Aug.	Gulf of Maine	Benthic algae	Robert Stenneck Univ. of Maine
30 Aug.-2 Sept.	Gulf of Maine	Midwater organisms	R. Harbison, Woods Hole Oceanographic Institution
31 Oct.-17 Dec. (J-S-L I)	Galapagos	Sponge, ascidians and macroalgae collections	K. Rinehart, Harbor Branch / SeaPharm Project

R/V EDWIN LINK, JOHNSON-SEA-LINK I:

25 Mar.-2 May	Cape Canaveral	Space Shuttle CHALLENGER	NASA
8-11 May	Cape Canaveral	DELTA ROCKET	NASA
10-26 June	Bahamas	Training	Harbor Branch Oceanographic Institution
9-18 July	New England	Dredging Effects	F. Serchuck, NMFS / NEFC
19 July-1 Aug.	Georges Bank		Page Valentine, USGS Joe Uzmann, NMFS
3-14 Aug.	Georges Bank	Demersal haddock and cod abundance	G. Lough, NMFS / NEFC
19-22 Aug.	Onslow Bay	Benthic macroalgae	L. Cahoon, University of North Carolina
23 Aug.-1 Sept.	Charleston, S.C.	Golden Crab	E. Wenner, S.C. Wildlife and Marine Resource Department
13-22 Sept.	Gulf of Mexico	Golden Crab	W. Lindberg, Univ. of Florida
23-30 Sept.	Gulf of Mexico	Benthic ecology	R. Avant, Minerals Mgmt. Svc.
13-29 Oct.	Bahamas	Midwater organisms Marine Snow Benthic Ecology	M. Youngbluth / Harbor Branch A. Alldredge / D. Hanisak / C. Young / J. Miller / Harbor Branch

R/V SEA DIVER:

1-13 June	Bahamas	Collections	Ed Armstrong, Harbor Branch / SeaPharm Project
19-20 June	Cape Canaveral	Recover thermograph	Ned Smith, Harbor Branch
22-26 June	Bahamas	Training	Harbor Branch
21 July-4 Aug.	Florida Keys and Dry Tortugas	Collections	Ed Armstrong, Harbor Branch / SeaPharm Project
20-29 Oct.	Bahamas	Benthic Ecology	D. Hanisak / C. Young / J. Miller / Harbor Branch
4-7 Nov.	Cape Canaveral, FL	Recover current meter and thermograph Replay current meter.	Ned Smith, Harbor Branch

Harbor Branch Oceanographic Institution, Inc.
Grants and Contracts
Funding by Division and Outside Source
1986/1985

	Actual 1986	Actual 1985
Marine Science:		
IRMCD-Mosquito / Marsh Study	\$ 22,089	\$ 14,600
Dept. of Health & Rehabilitative Svces. – Carbon Flux Mosquito Study	13,097	4,366
Dept. of Environmental Regulation / FL Seagrant	20,650	—
NOAA – Looe Key	2,538	8,147
Dept. of Environmental Regulation – Mosquito Study	9,000	—
Dept. of Health & Rehabilitative Svces. – Mosquito Impoundment Study	36,687	—
NSF – Larval Study	16,087	699
Dept. of Health & Rehabilitative Svces. – Culvert Densities Study	23,161	12,229
NSF / Mar. Biol. Lab – Fish Study	40,947	17,843
NOAA – Molasses Reef Algae Study	84,010	78,043
Other	29,492	120,104
	<u>297,758</u>	<u>256,031</u>
Applied Biology:		
Solar Energy Research Inst. – Microalgae-Energy	32,211	76,392
NOAA – Upwelling Study	4,918	3,000
Foundation for Pride – Aquaculture Consulting	5,183	2,764
Office of Navy Research – Oyster Study	99,870	—
USAID (Haiti & Belize) – Aquaculture Consulting	8,573	3,533
WED/EPCOT-Living Seas – Aquaculture Consulting	6,187	7,312
USAID-Antigua – King Crab Study	185,196	—
NSF – Agar Study	36,330	4,936
Gas Research Institute – Biomass Study	98,364	181,418
NSF – Sargassum Study	73,441	9,574
NOAA – Hydrographic Processes Study	18,637	—
Dept. of Health & Rehabilitative Svces. – Mosquito Toxicity Study	21,770	83,375
Other	11,258	84,538
	<u>601,938</u>	<u>456,842</u>
Harbor Branch / SeaPharm Project:		
National Cancer Institute – Deepwater Collection	190,063	—
NCI – Small Business Contracts	6,508	—
American Cyanamid	56,595	—
Subtotal	253,166	—
SeaPharm, Inc.	877,123	559,593
	<u>1,130,289</u>	<u>559,593</u>
Ocean Engineering:		
US Navy-D. Taylor – Pan Assembly	42,001	19,818
RCA – Inertial Navigation System Survey	31,134	—
Dept. of Health & Rehabilitative Svces. – Mosquito Toxicity Study	15,730	4,125
City of Vero Beach – Water Study	11,000	11,820
Piper Aircraft – Water Study	14,500	13,000
Ft. Pierce Utilities – Water Study	9,765	—
FP&L – Coating Study	12,263	—
Other	4,425	33,632
	<u>140,818</u>	<u>82,395</u>
Marine (Ship / Submersible) Operations:		
NOAA – Special Missions	833,491	919,000
Univ. of California – (NSF)	85,050	—
Univ. of Connecticut – Avery Point (NOAA)	747,952	812,500
Eastport Int'l. – Space Shuttle	1,361,611	—
LGL Ecological Research Assoc.	57,261	—
Johnson Fund (Smithsonian)	552,486	494,912
All Other	—	20,000
	<u>3,637,851</u>	<u>2,246,412</u>
General:		
The Atlantic Foundation – Marine Science and Ocean Engineering Programs	2,500,000	2,800,000
Johnson Charitable Trusts – Construction of research vessel SEWARD JOHNSON	1,500,000	1,500,000
Link Foundation – Summer Interns & HB Video	7,175	7,150
Marion Clayton – Summer Intern Program	5,355	—
	<u>4,012,530</u>	<u>4,307,150</u>
	<u>\$9,821,184</u>	<u>\$7,908,423</u>

- * No longer with Harbor Branch,
as of December 31, 1986
** Educational Leave of Absence
Part Time
† Harbor Branch Personnel on
Harbor Branch/SeaPharm Staff

Personnel Listing

HARBOR BRANCH ADMINISTRATION

Jay Langfelder, Ph.D.
Vice President and
Managing Director
Kevin Eckelbarger, Ph.D.
Acting Director, Division of
Marine Sciences
John Ryther, Ph.D.
Director, Division of Applied
Biology
Jacob Clement, Ph.D.
Harbor Branch/SeaPharm
Biology Department Head
Gabriel Saucy, Ph.D.
Harbor Branch/SeaPharm
Chemistry Department Head
David L. Clayton
Director, Division of
Ocean Engineering
Roger Cook
Director, Division of
Marine Operations
Richard Herman
Director of Finance and
Controller of Operations
Frederick Gallagher
Properties Manager
Monica J. Hickey
Personnel Manager
Susan van Hoek
Public Affairs Coordinator

MANAGING DIRECTOR'S OFFICE

Jay Langfelder, Ph.D.
Vice President and
Managing Director
Rose Neville
Administrative Secretary

DIVISION OF MARINE SCIENCES

Kevin Eckelbarger, Ph.D.
Acting Director of Marine
Sciences
Senior Research Scientist
Ned Smith, Ph.D.
Senior Research Scientist
Marsh Youngbluth, Ph.D.
Senior Research Scientist
Grant Gilmore
Assistant Research Scientist
Dennis Hanisak, Ph.D.
Assistant Research Scientist
Craig Young, Ph.D.
Assistant Research Scientist
John Miller
Chief Curator
Kristen Metzger
Librarian

Thomas Smoyer
Photographer

Thomas Bailey, Ph.D.
Research Associate
Anne Bergey
Research Assistant I
Brian Bingham
Research Assistant II
Steve Blair
Research Assistant II
Ronald Brockmeyer
Research Assistant I
* Carol Browder
Assistant Librarian
Gwen Burzycki
Research Assistant I
Lane Cameron, Ph.D.
Research Associate
*James Dalby
Research Assistant I
Peter Davoll, Ph.D.
Research Associate
*Ellen Ditchett
Darkroom Technician
Pamela Blades-Eckelbarger
Research Assistant II
*Libby Ely
Darkroom Technician
*James Fyfe
Research Assistant I
Leon Heffelfinger
Darkroom Technician
Peter Hood
Research Assistant II
Doreen Keller
Office Services Supervisor
Patricia Linley
Research Assistant II
Benjamin McLaughlin
Research Assistant I
Carol Meo
Manuscript Typist
*Paul Mikkelsen
Applications Programmer
Paula Mikkelsen
Assistant Curator
Dennis Peters
Research Assistant I
Patrick Pitts
Research Assistant II
*Mary Price
Research Assistant I
Mary Samuel
Research Assistant I
Doug Scheidt
Research Assistant I
*Carmelita Sherwood
Manuscript Typist
*Joel Strasser
Research Assistant I
Jena Swindle
Research Assistant I
*Derek Tremain
Research Assistant I
Frederick Zechman
Research Assistant I
*Carl Zimmerman
Research Assistant II

DIVISION OF APPLIED BIOLOGY

John Ryther, Ph.D.
Director, Division of
Applied Biology
Roy Laughlin, Ph.D.
Senior Research Scientist
Kimon Bird, Ph.D.
Associate Research Scientist
Brian LaPointe, Ph.D.
Associate Research Scientist
David Vaughn, Ph.D.
Associate Research Scientist
Robert Winfree, Ph.D.
Assistant Research Scientist
Leroy Creswell
Research Associate
Peter Pendoley
Research Associate
John Chaiton
Onsite Project Manager /
Antigua
John Holt
Senior Aquaculture Engineer
Ruth Aldrich
Typist
*Dee Arnold
Building Mechanic
Richard Baptiste
Research Assistant I
*Gabriele Bulcke
Research Assistant I
Gerri Collins
Administrative Assistant
Brenda Daugherty
Research Assistant I
*Robert Eifert
Research Assistant I
*Jean Michel Guerin
Laboratory Assistant
Barbara Gustafson
Research Assistant II
*Robert Halliday
Project Engineer
Julie O'Connell
Research Assistant I
Frederico Prah
Laboratory Assistant
*Mary Schilling
Research Assistant II
Roy Spor
Associate Aquaculture
Engineer
*Debra Wescott
Research Assistant I
Richard Wingrove
Research Assistant II / Antigua
*Gail Woon
Research Assistant I
Jacob Clement, Ph.D.
Biology Department Head
Gabriel Saucy, Ph.D.
Chemistry Department Head
May Lui, Ph.D.
Biology Group Leader
Oliver McConnell, Ph.D.
Chemistry Group Leader
David Newman, Ph.D.
Biology Group Leader
*Raphael Pappo, Ph.D.
Chemistry Group Leader /
Synthesis
Shirley Pomponi, Ph.D.
Senior Taxonomist
*James Rake, Ph.D.
Biology Group Leader
Kenneth Rinehart, Ph.D.
Research Director
*Kenneth Snader, Ph.D.
Chemistry Department Head
James E. Armstrong, Ph.D.
Senior Research Scientist
Sue Cross, Ph.D.
Senior Research Scientist
Sarath Gunasekera, Ph.D.
Senior Research Chemist
*Hans Hummel, Ph.D.
Senior Research Chemist
Frank Koehn, Ph.D.
Senior Research Chemist
Shigeo Komoto, Ph.D.
Senior Research Chemist
Peter McCarthy, Ph.D.
Senior Research Scientist
Richard Wood, Ph.D.
Senior Research Chemist
Amy Wright, Ph.D.
Senior Research Chemist
Belinda Alvarado
Associate Scientist II
Rudolpho Cadilla
Associate Scientist III
Susan Cranick
Associate Scientist I
Christina Diaz
Research Technician
*Keith Ferris
Laboratory Technician
*Dorilyn Forleo
Research Technician
Molika Gunasekera
Associate Scientist II
Toshio Ichiba
Associate Scientist III
Kathleen Janda
Research Technician
Paul Jensen
Research Technician
†Joan Kaminski
Executive Secretary
Julie Kaser
Laboratory Technician
Heather Kirby
Laboratory Assistant

Thomas Lewis
Research Technician

*Jeffrey Martin
Laboratory Technician

Stephen Maurer
Research Technician

Lisa Moritz
Research Technician

Nadine Neil
Associate Scientist

Tara Peterson
Research Technician

*Barbara Rake
Research Technician

†Catherine Rossmell
Receptionist/Data Entry Clerk

Ryuichi Sakai
Associate Scientist III

Shinichi Sakemi
Associate Scientist III

*Susan Sennett
Associate Scientist III

Dedra Stewart
Research Technician

†Jayne Voigt
Administrative Secretary

DIVISION OF OCEAN ENGINEERING

David L. Clayton
Director, Ocean Engineering

Frank Cairni, Ph.D.
Chief Electronics Engineer

Robert Dolan
Chief Design Engineer

Tsen Wang, Ph.D.
Chief Chemical Engineer

**Andrew Clark
Principal Mechanical Engineer

Thomas Cerwonka
Computer Services Manager

Charles Brenn
Mechanical Engineer I

Thomas Cherubino
Applications Programmer

*Ricardo de La Fuente
Applications Programmer

Deborah Farb
Administrative Assistant

James Hastings
Drafting Designer II

Charles Hendry
Chemical Engineering
Technician I

Lisa Hoberty
Electronics Technician I

*Andrea Hrusovsky
Chemical Engineering
Technician I

Elroy Hull
Drafting Designer II

Michael C. Hyde, Sr.
Machinist II

Todd Kadlac
Chemical Engineering
Technician II

*Robert Lenahan
Chemical Engineer II

Damiris (Dee Dee) O'Brien
Computer Operator/
Tape Librarian

Bruno Peterson
Machinist II

Dennis Pickerill
Lead Fabricator

Robert Quinn (Ret.)
Drafting Supervisor

Mark Schmalz
Electronics Engineer I

Lloyd Scott
Fabrication & Layout Person

Jeffrey Smith
Welder II

Lawrence Taylor
Associate Electronics
Engineer

Richard C. Tietze
Mechanical Engineer I

Robert Tustling
Senior Systems Engineer

Quentin Voyles
Programmer Analyst

*Kenneth Wetzel
Chemical Engineering
Technician I

William (Tony) H. Wilson
Drafting Supervisor

Jack Yager
Fabrication & Layout Person

Michael Young
Mechanical Engineering
Technician I

DIVISION OF MARINE OPERATIONS

Roger Cook
Director, Marine Operations

Timothy Askew, Sr.
Manager, Undersea Vehicles

Daniel Schwartz
Captain,
R/V SEWARD JOHNSON

Arthur Plante
Captain, R/V EDWIN LINK

Edmond Warren
Captain, R/V SEA DIVER

Danny Saunders
Port Engineer

Michael Adams
Submersible Pilot

Jerome Anderson
Submersible Technician I

Henry Ashburn
Mechanic II

Timothy Askew, Jr.
Assistant Engineer,
R/V EDWIN LINK

Louis Blaisdell
Supervisor,
Remotely Operated Vehicles

Richard Bourette
Painter

James Buckley
Assistant Engineer,
R/V SEWARD JOHNSON

Craig Caddigan
Submersible Pilot

Michael Camp
Submersible Technician I

Michael Clark
Mate, R/V SEA DIVER

*Rodney Coffman
Mechanic II

Thomas Couture
Submersible Technician I

Marshall Flake
Chief Submersible Pilot

Rudy Fleck
Chief Mate,
R/V SEWARD JOHNSON

*Stevan Hall
Submersible Pilot

Ronald Hitchcock
Submersible Technician I

Bruce Hoebake
Cook/Steward,
R/V EDWIN LINK

Michael Hyde, Jr.
Chief Engineer,
R/V SEWARD JOHNSON

Bruce Kay
Chief Mate, R/V EDWIN LINK

Pamela Keen
Executive Secretary

Gregory Kennedy
Submersible Technician II

Wesley Knight
Chief Engineer,
R/V SEA DIVER

*Patrick Lahey
Submersible Technician I

David Lamb
Steward,
R/V SEWARD JOHNSON

Conrad Lavander
Marine Maintenance
Manager

Dominic Liberatore
Senior Submersible Pilot

*Daniel Meads
Mechanic I

*Robert Moore
Senior Submersible
Technician

Steven Nelson
Submersible Pilot

David Norquist
Submersible Technician I

Kenneth O'Brien
Submersible Technician I

*Russell Pinkham
Seaman,
R/V SEWARD JOHNSON

*Richard Potts
Mechanic I

John Reed
Mission Coordinator/
Dive Safety Officer

Dwayne Rhea
Marine Maintenance
Mechanic I

Fredrick (Dan) Sandall
Marine Maintenance
Mechanic II

Philip Santos
Submersible Technician I

James Sullivan
Supervisor,
Submersible Electronics

Michael Sullivan
Submersible Technician II

Paul Tell
Seaman/Cook,
R/V SEA DIVER

Paul Tisevich
Mate, R/V SEWARD JOHNSON

Ralph van Hoek
Seaman,
R/V SEWARD JOHNSON

Christopher Vogel
Mate, R/V EDWIN LINK

John Webb
Marine Mechanic II

Joseph Weissenberg
Submersible Technician I

Terry Ziegler
Chief Engineer,
R/V EDWIN LINK

Paul Zobel
Seaman/Utilityman,
R/V SEWARD JOHNSON

FINANCE DIVISION

Richard J. Herman
Director of Finance &
Controller of Operations

Katherine Barton
Accounting Manager

Charles Slaughter
Grants & Contracts Officer

Grayson Bell
Purchasing Manager

*Michael Behr
Driver/Receiving Clerk

Janka Cameron
Driver/Receiving Clerk

Stella Chavez
Accounting Data Clerk

Leroy Clemenzi
Buyer

*Betty Dexter
Accounting Data Clerk

*Maria Fogarty
General Bookkeeping
Supervisor

John Hassett
Shipping/Receiving Clerk

Wanda High
Purchasing Clerk

*Michelle Jenkins
Accounting Data Clerk

Debbie Lang
Cost System Coordinator

Margaret McNamara
Bookkeeper/Payroll

Deborah Sanders
Accounting Data Clerk

Mary Wogish
General Accounting
Bookkeeper

Carolyn Zealand
Administrative Secretary

PROPERTIES

Frederick Gallagher
Properties Manager

Ronald Witherow
Construction and
Maintenance Manager
Lionel Johnson
Chief Gardener

Roy Ashburn
Gardener
Thomas Baumker
Building Superintendent II
Ronald Bowman
Electrician II
Albert Csontos
Mechanical Maintenance
Supervisor

Kenneth Day
Building Superintendent II
Michael DuBrosky
Gardener
Ronald Fountain
Heavy Equipment Operator
*Norvell Gaynor
Gardener
*Harold Hatch
Laborer
Robert Keller
Chief Carpenter
Joe Miller
Painter
Henry Moore (Ret.)
Building Superintendent II
Annell Nelson
Administrative Assistant

James Neville
Equipment Mechanic
George Pallo
Maintenance Mechanic II
*David Pettinga
Painter
Richard Sadler
Maintenance Mechanic II
*Kenneth Singley
Heavy Equipment Operator
Robert Stone
Laborer
Carl Woodrow
Working Foreman

PERSONNEL SERVICES

Monica J. Hickey
Personnel Manager
*Suzanne Hunter
Switchboard Operator/
Receptionist
Marilyn Morris
Switchboard Operator/
Receptionist
Janice Richards
Personnel Assistant

PUBLIC AFFAIRS OFFICE

Susan van Hoek
Public Affairs Coordinator
Cherrie Schreiber
Public Affairs Sec/Assistant

Fellows, Students, Associates & Visitors

POSTDOCTORAL FELLOWS

Roland Carlson
Division of Applied Biology
Southern Illinois University
Steve Coval
HB/SeaPharm
University of Hawaii
Glynn Faircloth
HB/SeaPharm
Boston University
Rick Gustafson
Division of Applied Biology
University of Victoria, Canada
Roger Hiner
HB/SeaPharm
University of Virginia
John Kilar
Marine Science
Dalhousi University, Nova Scotia
Ron Larson
Marine Science
University of Victoria, Canada
Mike Liou
Engineering
University of Texas at Austin
Scott McEuen
Marine Science
University of Alberta, Canada
Richard Matheson
Marine Science
Texas A & M
George Shinn
Marine Science
University of Washington
Peggy Strumski
Division of Applied Biology
University of Miami
Chee Kai Tan
Engineering
Auburn University
Catherine Thompson
Division of Applied Biology
Lehigh University

Winnie Theiss Thompson
HB/SeaPharm
Wright State University
John Tucker
Division of Applied Biology
College of William & Mary
Clint Turbeville
Marine Science
Clemson University

GRADUATE STUDENTS

Brian Bingham
Florida State
James Dalby
Florida State
Ivone Fernandes
University of Florida
Jean Michael Guerin
Ecole Nationale Supérieure
Agronomique de Rennes,
France
Philippe Gondouin
University of Paris, France

CO-OP STUDENTS

David Hodgkins
Florida Institute of Technology
Joseph DeGiorgis
Florida Institute of Technology

SMITHSONIAN RESIDENT STAFF

Dr. Mary E. Rice
Scientist-in-Charge
Lorraine Brouillard
William Lee
Julie Pirano
Sherry Reed
Hugh Reichardt

SUMMER INTERNS

Silas Campbell
City College, Vanderbilt
Kevin Cute
Humboldt State University
Tim Hood
Washington University
David Inglin
Stockton State College
Jerry O'Connor
Indian River Community
College
Colleen O'Meara
University of Florida
Pamela Pape
University of Miami
Susie Somerlot
Agnes Scott College
Sheri Weinsten
Rollins College
Richard Wilson
Florida Institute of Technology

VISITING INVESTIGATORS

Dr. Llewellyn Hillis Colinvaux
Ohio State University
Dr. Sam Gruber
Rosenstiel School of Marine
and Atmospheric Sciences
University of Miami
Dr. Giselher Gust
University of South Florida
Dr. Charles A. Jacoby
Leigh Marine Laboratory
University of Auckland, New
Zealand

Dr. Michael Keough
Florida State University
Dr. Chris Lobban
University of New Brunswick,
Canada
Dr. Adam Marsh
Chesapeake Biological
Laboratory
University of Maryland
Dr. Tsuguo Otake
University of Tokyo
Dr. David Pawson
National Museum of Natural
History
Smithsonian Institution
Dr. David Petch
University of Melbourne,
Australia
Dr. Luis Rivas
Nova University
Mr. Jon Schmidt
Florida State University
Dr. R.L. Turner
Florida Institute of Technology

HARBOR BRANCH/ SEAPHARM PROJECT VISITING SCIENTISTS

Dr. Tatsuo Higa
Chemistry Group Leader
Shulamit Hirsch
Associate Scientist III
Dr. Yoel Kashman
Chemistry Group Leader
Peter Murphy
Senior Research Chemist

Publications

Complete listing of 1986 publications resulting from Harbor Branch research, as of December 31, 1986, and including 1984, 1985 publications not listed in the last Harbor Branch Profiles, published April, 1985. Harbor Branch contribution numbers appear at the end of each entry.

Aldredge, Alice L. and Marsh J. Youngbluth. 1985. The

significance of macroscopic aggregates (marine snow) as sites for heterotrophic bacterial production in the mesopelagic zone of the subtropical Atlantic. *Deep Sea Research* 32: 1445-1456. 461.

Arnold, William S. 1984. The effects of prey size, predator size and sediment composition on the rate of predation of the blue crab, (*Callinectes sapidus* Rathbun) on the hard clam, *Mercenaria mercenaria* (Linne). *Journal of Experimental Marine Biology and Ecology* 80(3): 207-220. 382.

Bailey, T.G. and B.H. Robinson. 1986. Food availability as a selective factor on the chemical compositions of midwater fishes in the eastern North Pacific. *Marine Biology* 91: 131-141. 487.

Barans, C.A., E.J. Gutherz and R.S. Jones. 1986. Submersible avoidance by yellowfin bass *Athias nicholsi*. *Northeast Gulf Science*. 8(1):91-95. 460.

Bird, Kimon and John Ryther. 1985. Aquatic plant aquaculture: a multiproduct/multiuse approach. IN: *Energy from Biomass: building on a generic technology base*; proceedings of the third technical review meeting, Argonne National Laboratory, National Technical Information Service # ANL/CNSV-TM-157. 397.

Bird, Kimon T. . Tropical macroalgal cultivation for bioconversion to methane. *Energy from Biomass and Wastes*. (In press). 497.

Bird, Kimon T., Brian E. Lapointe, Dennis Hanisak, John H. Ryther and Clinton Dawes. . Alternative production systems - marine crops. IN: *Methane from Biomass - a Systematic Approach*. Editors: W. Smith and J. Frank. New York, Elsevier Publishing Co. (In press). 511.

Blades-Eckelbarger, Pamela I. . Aspects of internal anatomy and reproduction in the Copepoda. *Proceedings of the Second International Conference on Copepoda*, Ottawa, Canada, 13-17 August 1984. (In press). 507.

Blair, Stephen M. . Productivity of *Microcoleus lyngbyaceus* (Cyanophyceae: Oscillatoriaceae) in various light and temperature conditions. *Botanica Marina*. (In press). 500.

Brenn, Charles B. and Andrew M. Clark. . Computer controlled deep ocean simulation and data acquisition system. *Marine Data Systems '86*. (In press). 501.

Byrne, Maria. 1985. Evisceration behaviour and the seasonal incidence of evisceration in the holothurian *Eupentacta quinquesemita* (Selenka). *Ophelia* 24(2): 75-90. 443.

Byrne, Maria. 1985. The life history of the gastropod *Thyonicola americana* Tikasingh, endoparasitic in a seasonally eviscerating holothurian host. *Ophelia* 24(2): 91-101. 444.

Byrne, Maria. 1986. Induction of evisceration in the holothurian *Eupentacta quinquesemita* and evidence for the existence of an endogenous evisceration factor. *Journal of Experimental Biology* 120: 25-39. 445.

Byrne, Maria. 1986. The ultrastructure of the morula cells of *Eupentacta quinquesemita* (Echinodermata: Holothuroidea) and their role in the maintenance of the extracellular matrix. *Journal of Morphology* 188: 179-189. 488.

Caimi, F.M., R.F. Tusting and G. Kennedy. 1984. In-situ forward scatter and transmittance measurement using a low power laser diode. *SPIE Proceedings* 489: 364-374. 378.

Caimi, F.M. and M.S. Schmalz. 1985. Geometric properties of non-differential contours: concurrent spatial harmonic and fractal analyses. *SPIE Proceedings*. 573: 21-29. 401.

Caimi, Frank M. 1985. Output power stabilization of collimated, solid-state laser emissions as applied to high accuracy attenuation measurements. *SPIE Proceedings*. 566: 358-367. 465.

Caimi, F.M. and R.F. Tusting. . Semiconductor laser-based instrumentation for ocean-optical studies: problems in design, testing and calibration. *SPIE Proceedings*. (In press). 502.

Caimi, Frank M. . Ocean-optical measurements using acousto-optic filtering. *SPIE Proceedings*. (In press). 503.

Caimi, Frank M. and Mark S. Schmalz. . A fractal geometric model of light pulse propagation in a multilayer ocean. *SPIE Proceedings*. (In press). 505.

Carlson, Douglas B., R. Grant Gilmore and Jorge R. Rey. 1985. Salt marsh impoundment management on Florida's central east coast: reintegrating isolated high marshes to the estuary. IN: *Proceedings of the 12th Annual Conference on Wetlands Restoration and Creation*. Tampa, Florida, Hillsborough Community College Environmental Studies Center, c1985. pp. 47-63. 453.

Cerwonka, Thomas. 1986. Advantages of scientific relational databases. *Proceedings of the Fourth Working Symposium on Oceanographic Data Systems*. Editor: Daniel Stieger. pp. 191-195. 481.

Clark, Andrew M. . Analysis of a composite fiber wrapped gas cylinder for deep diving submersible. *Proceedings of the 1986 Energy Sources Technical Conference (ASME)*. (In press). 454.

Clark, Andrew M. . Design and construction of an aluminum A-Frame for submersible launch and recovery. *Proceedings of the 1986 Energy Sources Technical Conference (ASME)*. (In press). 457.

Clark A.M. and R.C. Tietze. . Remotely operated tools for undersea vehicles. *Proceedings of the 1986 Energy Sources Technical Conference (ASME)*. (In press). 456.

Cole, G.L. and M.D. Hanisak. 1986. Production and properties of native agars from *Gracilaria tikvahiae* and other red algae. *Botanica Marina* 29: 359-366. 484.

Davoll, P.J. and M.W. Silver. 1986. Marine snow aggregates: life history sequence and microbial community of abandoned larval houses from Monterey Bay, California. *Marine Ecology - Progress Series*. 33:111-120. 517.

DeBusk, T.A. and F.E. Dierberg. 1984. The effect of nitrogen and fiber content on the decomposition of the water hyacinth (*Eichhornia crassipes* [Mart.] Solms). *Hydrobiologia* 118(2): 199-204. 422.

DeBusk, Thomas A., Mark Blakeslee and John H. Ryther. . Studies on the outdoor cultivation of *Ulva lactuca*. *Botanica Marina*. (In press). 508.

Eckelbarger, K.J. 1984. Ultrastructure of spermatogenesis in the reef building polychaete *Phragmatopoma lapidosa* with special reference to acrosome morphogenesis. *Journal of Ultrastructure Research* 89: 146-164. 394.

Eckelbarger, K.J. and J.P. Grassie. . Spermatogenesis, sperm storage and comparative sperm morphology in nine species of *Capitella*, *Capitomastus* and *Capitellides* (Polychaeta: Capitellidae). *Marine Biology*. (In press). 534.

Eckelbarger, K.J. . Vitellogenic mechanisms and the allocation of energy to offspring in polychaetes. *Bulletin of Marine Science*. (In press). 535.

Eckelbarger, K.J. and J.P. Grassie. . Interspecific variation in genital spine, sperm and larval morphology in six sibling species of *Capitella*. *Proceedings of the Biological Society of Washington*. (In press). 536.

Eckelbarger, K.J. . Oogenesis and female gametes. IN: *The Ultrastructure of the Polychaeta*. Editors: W. Westheide and C.O. Hermans. New York, Gustav Fischer. (In press). 537.

Edgerton, Harold E., Harold A. Moffitt, and Marsh J. Youngbluth. 1984. High speed silhouette photography of live zooplankton. IN: *Underwater Photography, Scientific and Engineering Applications*. Compiled by Paul Ferris Smith. New York, Van Nostrand, c1984. pp. 305-319. 214.

Gerritsen, Jeroen, John D. Orcutt, Jr., and Karen G. Porter. 1985. Reply to Schoenberg. *Ecology* 66(3): 1088-1090. 458.

Gibson, Robert A. and F. Carol Stephens. 1985. Valve structure in *Mastogloia rostrata* with a comparison of intercalary band internal construction in two dissimilar diatom species. *Cryptogamiae Algologie* 6(1): 13-24. 416.

- Gibson, R.A. and R.K. Mahoney. 1984. Comparative valve and angular structure in *Biddulphia tiftiana* (Grunow) Grunow in van Heurck and *Trigonium articum* (Brightwell) Cleve (Bacillariophyceae). *Proceedings of the National Academy of Sciences* 136: 200-217, 392.
- Gilmore, R.G. . Subtropical-tropical seagrass communities of the southeastern United States: fish and fish communities. *Proceedings of the American Institute of Biological Sciences Seagrass Symposium*, Gainesville, Florida. (In press). 469.
- Gilmore, R. Grant. Mangrove forests: animal communities. IN: *Biotic Communities of the Southeastern United States: terrestrial communities*. University of Kentucky Press. (In press) 540.
- Grimes, Churchill, Ken W. Able and Robert S. Jones. Tilefish *Lopholatilus chamaeleonticeps* habitat, behavior and community structure in the mid-Atlantic and southern New England waters. *Environmental Biology of Fishes*. (In press). 478.
- Gustafson, Richard G., Barbara D. Gustafson and Robert G.B. Reid. . Continuous reproduction in the Protobranch bivalve *Solemya reidi* (Cryptodonta, Solemyidae). *The Veliger*. (In press). 532.
- Habig, C., D.A. Andrews, and J.H. Ryther. 1984. Nitrogen recycling and methane production using *Gracilaria tikvahiae*: a closed system approach. *Resources and Conservation* 10(4): 303-313, 407.
- Henry, Eric. 1984. Syringodermales ord. nov. and Syringoderma floridae sp. nov. (Phaeophyceae). *Phycologia* 23(4): 419-426, 379.
- Henry, Eric. . Morphologies and life histories of *Onslowia bahamensis* sp. nov. and *Verosphacela ebrachia* gen. et sp. nov., with a reassessment of the Choristocarpaceae (Sphacelariales, Phaeophyceae). *Phycologia*. (In press). 525.
- Henry, Eric. . The life history of *Onslowia endophytica* (Sphacelariales, Phaeophyceae) in culture. *Phycologia*. (In press). 526.
- Hoskin, Charles M. and Daniel A. Sundeen. 1985. Grain size of granite and derived grus. Enchanted Rock Pluton, Texas. *Sedimentary Geology* 42: 25-40, 372.
- Hoskin, Charles M. and John K. Reed. 1985. Carbonate sediment produced by the rock-boring urchin *Echinometra lucunter* and endolithic infauna at Black Rock, Little Bahama Bank. IN: *The Ecology of Coral Reefs*. Editor: M.L. Reaka. Symposia Series for Undersea Research, Volume 3(1). Rockville, Maryland, Office of Undersea Research, NOAA, 1985. pp.151-161, 390.
- Hoskin, Charles M., John. K. Reed and David H. Mook. 1986. Production and offbank transport of carbonate sediment, Black Rock, southwest Little Bahama Bank. *Marine Geology* 73: 125-144, 490.
- Howard, Robert K. 1985. Measurements of short-term turnover of epifauna within seagrass beds using an *In situ* staining method. *Marine Ecology — Progress Series* 22: 163-168, 432.
- Howard, Robert K. and Frederick T. Short. 1986. Seagrass growth and survivorship under the influence of epiphyte grazers. *Aquatic Botany* 24: 287-302, 486.
- Hummel, Hans E. 1984. The tandem gas chromatography-behavior bioassay. IN: *Techniques in Pheromone Research*. New York, Springer-Verlag. Chapter 8. pp. 191-216, 377.
- Jensen, Paul R., Robert A. Gibson, Mark M. Littler and Diane S. Littler. 1985. Photosynthesis and calcification in four deep-water *Halimeda* species (Chlorophyceae, Caulerpales). *Deep Sea Research* 32(4): 451-464, 396.
- Jensen, Paul R. and Robert A. Gibson. 1986. Primary production in three subtropical seagrass communities: a comparison of four autotrophic components. *Florida Scientist* 49(3): 129-141, 482.
- Kerschner, B.A., M.S. Peterson and R.G. Gilmore. 1985. Ecotopic and ontogenetic trophic variation in Mojarras (Pisces: Gerreidae). *Estuaries* 8(3): 311-322, 470.
- Kilar, John A. and J. McLachlan. 1986. Branching morphology as an indicator of environmental disturbance: testing the vegetative fragmentation of *Acanthophora spicifera* and the turf morphology of *Laurencia papillosa*. *Aquatic Botany* 24: 115-130, 493.
- Kilar, John A. and Robin M. Lou. 1986. The subtleties of camouflage and dietary preference of the decorator crab, *Microphrys bicornutus* Latreille (Decapoda: Brachyura). *Journal of Experimental Marine Biology and Ecology* 101: 143-160, 509.
- Kilar, John. . Ecological studies of the alga *Acanthophora spicifera* (Vahl) Borg. (Ceramiales, Rhodophyta): vegetative fragmentation. *Journal of Experimental Marine Biology and Ecology*. (In press). 527.
- Kilar, John. . The structure and seasonality of benthic assemblages inhabiting an alga-dominated fringing-reef platform (Caribbean, Panama). *Smithsonian Contributions to the Marine Sciences*. (In press). 528.
- Landau, Matthew. 1984. The effects of aldicarb on two microcrustaceans. *Georgia Journal of Science* 42: 61-62, 414.
- Landau, M. and J.P. Riehm. 1985. The nutritional chemistry of the decapsulated cysts of four geographical strains of the brine shrimp *Artemia salina* (L.). *Comparative Biochemistry and Physiology* 81(3A): 551-554, 427.
- Lapointe, Brian E. and Pamela K. Miller. . *In situ* nitrogen and phosphorus limited photosynthesis and growth of a *Gracilaria tikvahiae* (Rhodophyceae) U.S.A. *Marine Ecology*. (In press). 436.
- Lapointe, Brian E. and M. Dennis Hanisak. . Productivity and nutrition of marine biomass systems in Florida. *Proceedings of Energy, Biomass and Wastes*. (In press). 437.
- Lapointe, Brian E. 1986. Phosphorus-limited photosynthesis and growth of *Sargassum natans* and *Sargassum fluitans* in the western North Atlantic. *Deep Sea Research* 33(3): 391-399, 477.
- Lapointe, Brian E. and Ned P. Smith. . Preliminary investigation of upwelling as a source of nutrients to Looe Key Marine Sanctuary. NOAA Technical Report. (In press). 491.
- Lapointe, Brian E. 1985. Strategies for pulsed nutrient supply to *Gracilaria* cultures in the Florida Keys: interactions between concentration and frequency of nutrient pulses. *Journal of Experimental Marine Biology and Ecology*. 93(3): 211-222, 475.
- Lapointe, Brian E., Mark M. Littler and Diane S. Littler. . A comparison of nutrient-limited productivity in macroalgae from a Caribbean barrier reef and mangrove ecosystem. *Aquatic Botany* (In press). 529.
- Larson, R.J. 1986. Water content, organic content, and carbon and nitrogen composition of *Medusae* from the northeast Pacific. *Journal of Experimental Marine Biology and Ecology* 99: 107-120, 515.
- Larson, R.J. 1986. Observations on the light-inhibited activity cycle and feeding behavior of the hydromedusa *Olindias tenuis*. *Studies on the Fauna of Curacao and Other Caribbean Islands* 68(118): 191-199, 516.
- Larson, R.J. 1986. Ova production by hydromedusae from the NE Pacific. *Journal of Plankton Research* 8(5): 995-1002, 523.
- Larson, R.J. 1986. Seasonal changes in the standing stocks, growth rates, and production rates of gelatinous predators in Saanich Inlet, British Columbia. *Marine Ecology — Progress Series* 33: 89-98, 518.
- Laughlin, Roy B., Jr. 1986. Bioaccumulation of tributyltin: the link between environment and organism. *Oceans '86* Volume 4. pp. 1206-1209, 514.
- Laughlin, Roy B., Jr. . Quantitative structure-activity studies of di- and triorganotin compounds. *Proceedings of the Second International Workshop on Quantitative Structure-Activity Relationships in Environmental Toxicology*. (In press). 524.

- Laughlin, Roy B. Jr., A.B. Cobet and H.E. Guard.** . Mechanisms of triorganotin toxicity to macroinvertebrates and the role of the biofilm as a controlled release medium. *Proceedings of the International Conference on Marine Biodeterioration*. (In press). 510.
- Laughlin, Roy B. Jr. and Harold E. Guard.** 1986. Biomonitoring: practice and concepts. *Oceans '86* Volume 3. pp. 862-866. 520.
- Leber, Kenneth M.** 1985. The influence of predatory decapods refuge and microhabitat selection on seagrass communities. *Ecology* 66(6): 1951-1964. 428.
- Leber, Kenneth M. and Holly S. Greening.** 1986. Community studies in seagrass meadows: a comparison of two methods for sampling macroinvertebrates and fishes. *Fishery Bulletin* 84(2): 443-450. 439.
- Lewis, F. Graham, III.** 1984. Distribution of macrobenthic crustaceans associated with *Thalassia halodule* and bare sand substrata. *Marine Ecology — Progress Series* 19: 101-113. 381.
- Linley, J.R., P.A. Linley and L.P. Lounibus.** 1986. Light and scanning electron microscopy of the egg of *Mansonella titillans* (Diptera: Culicidae). *Journal of Medical Entomology* 23(1): 99-104. 447.
- Liou, M.C. and T.C. Wang.** Modeling of axial flow canisters for carbon dioxide-lithium hydroxide absorption in underwater life support systems. *Proceedings of the Energy Sources Technology Conference*. (In press). 542.
- Littler, Mark M., Diane S. Littler, Stephen M. Blair and James N. Norris.** 1985. The deepest known plant life on earth is discovered on an uncharted seamount. *Science* 227: 57-59. 374.
- Littler, Mark M., Diane S. Littler, Stephen M. Blair and James N. Norris.** 1986. Deepwater plant communities from an uncharted seamount off San Salvador Island, Bahamas: distribution, abundance and primary productivity. *Deep Sea Research*. 33(7A): 881-892. 489.
- McEachran, John D. and Richard E. Matheson, Jr.** Analysis of polychromatism and polymorphism within *Breviraja spinosa* (Elasmobranchii, Rajiformes). *Copeia*. (In press). 429.
- Main, Kevan L.** 1985. The influence of prey identity and size on selection of prey by two marine fishes. *Journal of Experimental Marine Biology and Ecology* 88: 145-152. 433.
- Main, Kevan L.** . Predator avoidance in seagrass meadows: an examination of prey behavior, microhabitat selection and cryptic coloration. *Ecology*. (In press). 471.
- Meltzer, Kristen L.** 1985. Document delivery in the small marine information center. *Proceedings of the Tenth Annual IAMSILC Conference*. Editors: R.L. Grundy and R.T. Ford. pp. 39-58. 391.
- Mikkelsen, Paul S.** 1985. A comparison of two Florida populations of the coquina clam, *Donax variabilis* Say, 1822 (Bivalvia: Donacidae). II. Growth rates. *The Veliger* 27(3): 308-311. 367.
- Mikkelsen, Paul S.** 1985. A rapid method for slide mounting of minute radulae, with a bibliography of radula mounting techniques. *The Nautilus* 99(2-3): 62-65. 451.
- Mikkelsen, Paula M.** 1986. A computerized database for a natural history collection. *Curator* 29(3): 191-203. 480.
- Miller, John E. and Richard L. Turner.** 1986. *Psolus pawsoni* (Echinodermata: Holothuroidea), a new bathyal sea cucumber from the Florida east coast. *Proceedings of the Biological Society of Washington* 99(3): 478-485. 530.
- Mills, Claudia E., Ronald J. Larson and Marsh J. Youngbluth.** . A new species of coronate scyphomedusa from the Bahamas, *Atorella octogonos* new species. *Bulletin of Marine Science*. (In press). 455.
- Montgomery, John and Barbara Bricker.** 1985. Sulfate analysis in saline waters using an automated turbidimetric method. *Florida Scientist*. 48(1): 51-58. 359.
- Montgomery, John R., Michael Hucks and Gary N. Peterson.** 1985. A portable non-contaminating sampling system for iron and manganese in sediment pore water. *Florida Scientist* 48(1): 46-49. 370.
- Montgomery, John R., Carl F. Zimmermann, Paul Jensen and Robert Gibson.** . Temporal and spatial occurrences of upwelling events off the southeast coast of Florida. *Continental Shelf Research*. (In press). 506.
- Mook, David.** 1985. Some preliminary observations on the homing of the West Indian chiton, *Acanthopleura granulata*. *The Veliger* 28(1): 115. 450.
- Mook, David H.** 1986. Absorption efficiencies of the intertidal mangrove dwelling mollusk *Melampus coffeus* Linne and the rocky intertidal mollusk *Acanthopleura granulata* Gmelin. *Marine Ecology* 7(2): 105-113. 498.
- Nail, Katherine L. and David L. Clayton.** 1984. Solving computer access needs — a local area network approach. *OCEANS '84* pp. 105-108. 385.
- Orcutt, John D., Jr.** . Food level effects on the competitive interaction to two co-occurring Cladoceran zooplankton: *Diaphanosoma brachyurum* and *Daphnia ambigua*. *Proceedings of the Symposium on Food Limitation in Structuring Zooplankton Communities*. (In press). 459.
- Paffenhofer, Gustav-Adolf and John D. Orcutt, Jr.** . Feeding, growth and food conversion of the marine plankton cladoceran *Penilia avirostris*. *Journal of Plankton Research*. (In press). 521.
- Pawson, David L. and John E. Miller.** . *Holothuria arenicola* Semper, 1868 (Echinodermata, Holothuroidea): proposed conservation by the suppression of *Holothuria humilis* Selenka, 1867. *ZN(S)2415. Bulletin of Zoological Nomenclature*. (In press). 538.
- Reed, John K.** 1985. Deepest distribution of Atlantic hermatypic corals discovered in the Bahamas. *Proceedings of the Fifth International Coral Reef Symposium*. Volume 6. pp. 249-254. 448.
- Reed, John K. and Paula Mikkelsen.** . The molluscan community associated with the scleractinian coral, *Oculina varicosa*. *Bulletin of Marine Science*. (In press). 541.
- Reed, John K. and Charles M. Hoskin.** . Biological and geological processes at the shelf edge investigated with submersibles. *Proceedings of the Undersea Research Symposium*. (In press). 395.
- Rice, Stanley A.** . Reproductive biology, systematics and evolution in the polychaete family Alciopidae. *Proceedings of the Biological Society of Washington*. (In press). 466.
- Riedel, Gerhardt F.** 1984. The influence of salinity and sulfate on the toxicity of Cr (VI) to the estuarine diatom *Thalassiosira pseudonana*. *Journal of Phycology* 20: 496-500. 373.
- Riedel, Gerhardt F., Stephanie L. Wilson and R.L. Holton.** 1984. Trace metals in the Columbia River estuary following the 18 May 1980 eruption of Mount St. Helens. *Pacific Science* 38(4): 340-349. 393.
- Riedel, Gerhardt F. and David M. Nelson.** 1985. Silicon uptake by algae with no known Si requirement. II. Strong pH dependence of uptake kinetic parameters in *Phaeodactylum tricornutum* (Bacillariophyceae). *Journal of Phycology* 21: 168-171. 434.
- Reidel, Gerhardt F.** 1985. Relationship between Chromium (IV) uptake, sulfate uptake and Chromium (IV) toxicity in the estuarine diatom *Thalassiosira pseudonana*. *Aquatic Toxicology* 7: 191-204. 462.
- Schmalz, Mark S. and Frank M. Caimi.** . Shift-invariant recognition of rotationally deformed ship silhouettes at multiple resolution scales. *SPIE Proceedings*. (In press). 504.
- Shinn, George L.** 1986. Life history and function of the secondary uterus of *Wahlia pulchella*, an umagillid turbellarian from the intestine of a northeastern Pacific sea cucumber (*Stichopus californicus*). *Ophelia* 25(2): 59-74. 522.
- Shinn, George L. and Richard A. Cloney.** 1986. Egg capsules of a parasitic turbellarian flatworm: ultrastructure of hatching sutures. *Journal of Morphology* 188: 15-28. 494.

- Shinn, George L.** . Spontaneous hatching of *Fallacohospes inchoatus*, and umagillid flatworm from the north-eastern Pacific crinoid *Florametra serratissima*. *Canadian Journal of Zoology*. (In press). 496.
- Shinn, George L.** . Two new species of umagillid flatworms from the 20-rayed antarctic crinoid, *Promachrocinus kerguelensis*. *Canadian Journal of Zoology*. (In press). 539.
- Shipp, Robert L., William A. Tyler III and Robert S. Jones.** 1986. Point count censusing from a submersible to estimate reef fish abundance over large areas. *Northeast Gulf Science* 8(1): 83-90. 499.
- Short, Frederick T.** 1985. A method for the culture of tropical seagrasses. *Aquatic Botany* 22(2): 187-193. 441.
- Short, Frederick T., Michael W. Davis, Robert A. Gibson and Carl F. Zimmermann.** 1985. Evidence for phosphorus limitation in carbonate sediments of the seagrass *Syringodium filiforme*. *Estuarine Coastal and Shelf Science* 20(4): 419-430. 375.
- Smith, Ned P.** 1985. The decomposition and simulation of the longitudinal circulation in a coastal lagoon. *Estuarine, Coastal and Shelf Science* 21: 623-632. 389.
- Smith, Ned P.** 1985. The suitability of routine weather data for estimating local estuarine heat energy fluxes. *Estuaries* 8(3): 270-278. 452.
- Smith Ned P.** 1985. Numerical simulation of bay-shelf exchanges with a one-dimensional model. *Contributions in Marine Science* 28: 1-13. 463.
- Smith, Ned P.** 1986. The rise and fall of the estuarine intertidal zone. *Estuaries* 9(2): 95-101. 519.
- Smith, Ned P.** . Subtidal exchanges between Corpus Christi Bay and Texas inner shelf waters. *Lecture Notes on Coastal and Estuarine Studies*. (In press). 446.
- Smith, Ned P.** . Computer simulation of wind-driven circulation in a coastal lagoon. *Proceedings of the Symposium on Circulation Patterns in Estuaries*. (In press). 495.
- Smith, Ned P.** . The Laguna Madre of Texas: hydrography of a hypersaline lagoon. IN: *Estuarine Hydrodynamics*. Editor: B.J. Kjerfve. Boca Raton, Florida, CRC Press. (In press). 512.
- Smith, Ned P.** . An introduction to the tides of Florida's Indian River lagoon. Part I: Water levels. *Florida Scientist*. (In press). 513.
- Stanley, B.H., H.E. Hummel, and W.H. Ruesink.** 1985. Estimating the maximum horizontal area of pheromone plumes. *Journal of Chemical Ecology* 11(8): 1129-1146. 430.
- Stoner, A.W. and F. G. Lewis, III.** 1985. The influence of quantitative and qualitative aspects of habitat complexity in tropical seagrass meadows. *Journal of Experimental Marine Biology and Ecology* 94: 19-40. 467.
- Tucker, J.W., Jr.** 1984. Hormone-induced ovulation of black sea bass females and rearing of larvae. *Progressive Fish-Culturist* 46(3): 201-203. 425.
- Tucker, J.W., Jr. and J.L. Laroche.** 1984. Radiographic techniques in studies of young fishes. IN: *Ontogeny and Systematics of Fishes*. Editor: H.G. Moser. Lawrence, Kansas, Allen Press, c1984. (American Society of Ichthyologists and Herpetologists. Special Publication no. 1). pp. 37-40. 426.
- Tucker, John W. Jr., Matthew P. Landau and Blake E. Faulkner.** 1985. Culinary value and composition of wild and captive common snook, *Centropomus undecimalis*. *Florida Scientist* 48(4): 196-200. 431.
- Tucker, John W. Jr.** 1986. Aging of common snook (*Centropomus undecimalis*) larvae using sagittal daily growth rings. *Northeast Gulf Science* 8(2): 173-176. 476.
- Turner, Richard L.** 1984. Revision of *Ophiopaepale* Ljungman 1872 (Echinodermata: Ophiuroidea), with a redescription of *O. goe-siana* Ljungman 1872 and notes on *O. diplex* (Nielsen, 1932), new combination. *Proceedings of the Biological Society of Washington* 97(4): 927-941. 380.
- Tusting, Robert F.** 1986. Non-conventional techniques for sampling and collecting marine organisms. *PACON '86* (Pacific Congress on Marine Technology) pp. MRM1/ 12-18. 483.
- Virstein, Robert W., Walter G. Nelson, F. Graham Lewis, III and Robert K. Howard.** 1984. Latitudinal patterns in seagrass epifauna: do patterns exist and can they be explained? *Estuaries* 7(4A): 310-330. 387.
- Virstein, Robert W. and Patricia A. Carbonara.** 1985. Seasonal abundance and distribution of drift algae and seagrasses in the mid-Indian River Lagoon, Florida. *Aquatic Botany* 23(1): 67-82. 472.
- Virstein, Robert W. and Mary Carla Curran.** 1986. Colonization of artificial seagrass versus time and distance from source. *Marine Ecology - Progress Series* 29: 279-288. 492.
- Voyles, Quentin and David Clayton.** 1986. A submersible-based data display and data logging system. IN: *Proceedings of the Fourth Working Symposium on Oceanographic Data Systems* Editor: Daniel Steiger. pp. 70-75. 479.
- Wang, T.C., R. Lenahan, M. Kanik and J. TenEyck.** 1985. The removal of trichloroethylene contaminated groundwater at Vero Beach, Florida. *Archives of Environmental Contamination and Toxicology* 14: 719-723. 468.
- Wang, T., R. Lenahan and M. Kanik.** 1985. Impact of trichloroethylene contaminated groundwater discharged to the main canal and Indian River Lagoon, Vero Beach, Florida. *Bulletin of Environmental Contamination and Toxicology* 34: 578-586. 383.
- Wang, T. and R. Lenahan.** 1986. Gasometric device for measuring CO₂ scrubber performance efficiency. *ASME Symposium Proceedings. Ocean Engineering Division* 11: 363-370. 474.
- Wang, T. C., R.A. Lenahan and T. Kadlac.** 1986. Environmental monitoring of volatile organics by purge-closed loop gas chromatograph. *Proceedings of the American Water Works Association. Water Quality Technology Conference* pp. 143-157. 485.
- Wang, T.C., R.A. Lenahan and J.W. Tucker, Jr.** . Deposition and persistence of aerially-applied fenthion in a Florida estuary. *Bulletin of Environmental Contamination and Toxicology*. (In press). 531.
- Wilson, W. Herbert, Jr.** 1986. Detachment of egg masses of a Molanid polychaete: risks of benthic protective development. *Ecology* 67(3): 810-815. 473.
- Wilson, W. Herbert, Jr.** 1985. Food limitation of asexual reproduction in a spionid polychaete. *International Journal of Invertebrate Reproduction and Development* 8(1): 61-66. 438.
- Young, Craig M., Paul G. Greenwood and Cynthia J. Powell.** 1986. Ecological significance of defensive secretions in the intertidal pulmonate *Onchidella borealis*. *Biological Bulletin* 171: 391-404. 533.
- Youngbluth, M.J.** 1984. Manned submersibles and sophisticated instrumentation: tools for oceanographic research. IN: *SUBTECH '83*: symposium proceedings. London, Society for Underwater Technology, c1984. pp. 335-344. 384.
- Youngbluth, Marsh J.** 1984. Water column ecology: In situ observations of marine zooplankton from a manned submersible. IN: *Divers, Submersibles and Marine Science*. Editor: N.C. Fleming. Memorial University of Newfoundland, *Occasional Papers in Biology*. Volume 9, pp. 45-57. 435.
- Zeeman, Stephen I.** 1985. Effects of tropical storm Dennis on coastal phytoplankton. *Estuarine, Coastal and Shelf Science* 20(4): 403-418. 442.
- Zimmermann, Carl F. and John R. Montgomery.** 1984. Effects of a decomposing drift algal mat on sediment pore water nutrient concentrations in a Florida seagrass bed. *Marine Ecology - Progress Series* 19: 299-302. 388.
- Zimmermann, C.F., J.R. Montgomery and P.R. Carlson.** 1985. Variability of dissolved reactive phosphate flux rates in nearshore estuarine sediments: effects of groundwater flow. *Estuaries* 8(2B): 228-236. 440.



Editor and Designer:

Susan van Hoek

Photos by Harbor Branch

Photographer:

Tom Smoyer

Printed By: Southeastern

Printing, Stuart, Florida,

USA



Harbor Branch
Oceanographic Institution, Inc.
5600 Old Dixie Highway
Fort Pierce, FL 33450